POWER

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The Job Higher Up

By R. T. Strohm

There are times when toil grows dreary
And the world seems none too kind,
And the worker's frame is weary
With the long-continued grind;
And the thing that keeps him going
When his nerve and strength have fled
Is the hope that comes with knowing
There's a better job ahead.

He is sure to be more willing
And less apt to lag and droop
If he knows that oil-cup filling
Or the swinging of a scoop
Will not haunt the years remaining
With its humdrum, but, instead,
Give experience and training
For the better job ahead.

He will throw his best endeavor
Into every phase of work,
And the chances are he'll never
Be a loafer or a shirk
If his modest occupation,
Though it yields him meat and bread,
Is a sort of preparation
For a better job ahead.

Nothing kills his high ambitions
Quite so thoroughly as when
He observes advanced positions
Go to new and unknown men;
So you really cannot blame him
If his spirit's dull and dead,
When you don't intend to name him
For the better job ahead.

The Ford Gas-Steam Plant

By Thomas Wilson

SYNOPSIS—Horizontal gas-steam engines rated at 6,000 hp. generate direct current at 250 volts. The ultimate capacity of the plant will be 54,500 hp. The jacket water of the gas engines is used as feed water for the boilers. The exhaust gases superheat the steam in the receiver between the high- and low-pressure cylinders of the steam engine, jacket the high-pressure steam cylinder, pass through closed feed-water heaters and are discharged into the stacks serving the boiler room through nozzles to increase the draft. In the heating season the latent heat of the steam is recovered in a forced hot-water system serving the entire manufacturing plant. The condensers are turned into heaters, and a vacuum corresponding with the temperature of the water is obtained.

In many ways Detroit is a remarkable city. It has a number of the largest institutions of their kind in the country, and of these the plant of the Ford Motor Co. is pre-eminent. Here initiative is encouraged, and when standard methods fail to meet requirements, there is no hesitancy in deviating from the beaten path to solve the problems at hand. It is not surprising then, that the power-generating equipment of this great company is novel and that it differs in arrangement and in the methods used to recover waste heat from any other installation in the country. An inadequate supply of water made impossible the high vacuums essential to the economy of a turbo-generator. Direct current could be used to the best advantage in the shops, and to drive large direct-current generators without intermediate gearing required a prime mover that would operate efficiently at relatively low speed. When the plant was conceived, the producer-gas engine was at its zenith. It was reliable to a certain degree, although more or less irregular in speed, but its heat efficiency was, and still is, greater than that of steam-driven units. To retain this high efficiency and safeguard it by the reliability and close regulation of the steam engine, the composite gas-steam unit was adopted at this plant. The largest steam boilers in the country and gas producers supply the power-producing mediums, and special devices extract the waste heat from the exhaust gases and the jacket cooling water.

The unit is arranged in the same way as a cross-compound steam engine, with a producer-gas engine having tandem cylinders on one side of the generator and a tandem-compound steam engine on the other side. Four units rated at 6,000 hp. and one at 5,000 hp., all of the composite type, have been in operation for some time. Another 6,000-hp. unit is being erected, and three more of the same size are under construction. This will make a total of nine gas-steam engines aggregating 53,000 hp. and, in conjunction with a straight 1,500-hp. steam engine, will make a total prime-mover capacity of 54,500 hp. for the plant. It is possible that there will be further additions, as the manufacturing plant is constantly growing, but whether they will be in the form of primary or secondary power will depend upon the power installation at the new tractor plant. The generators (which are 250-volt direct-current two-wire Crocker-Wheeler machines) will consist of eight 4,000-, one 3,000- and one 750-kw. units which will give a continuous full-load capacity of 35,750 kw. With the additional demand from the shops now under construction, a winter load approaching 20,000 kw. is expected, so that there should be ample reserve power for all emergencies. The gas engines are of the four-cycle double-acting type with water-cooled cylinders 42x72 in. The steam cylinders of the 6,000-hp. composite unit are 36 and 68 by 72 in., those of the 5,000-hp. unit are 30 and 56 by 72 in., while the

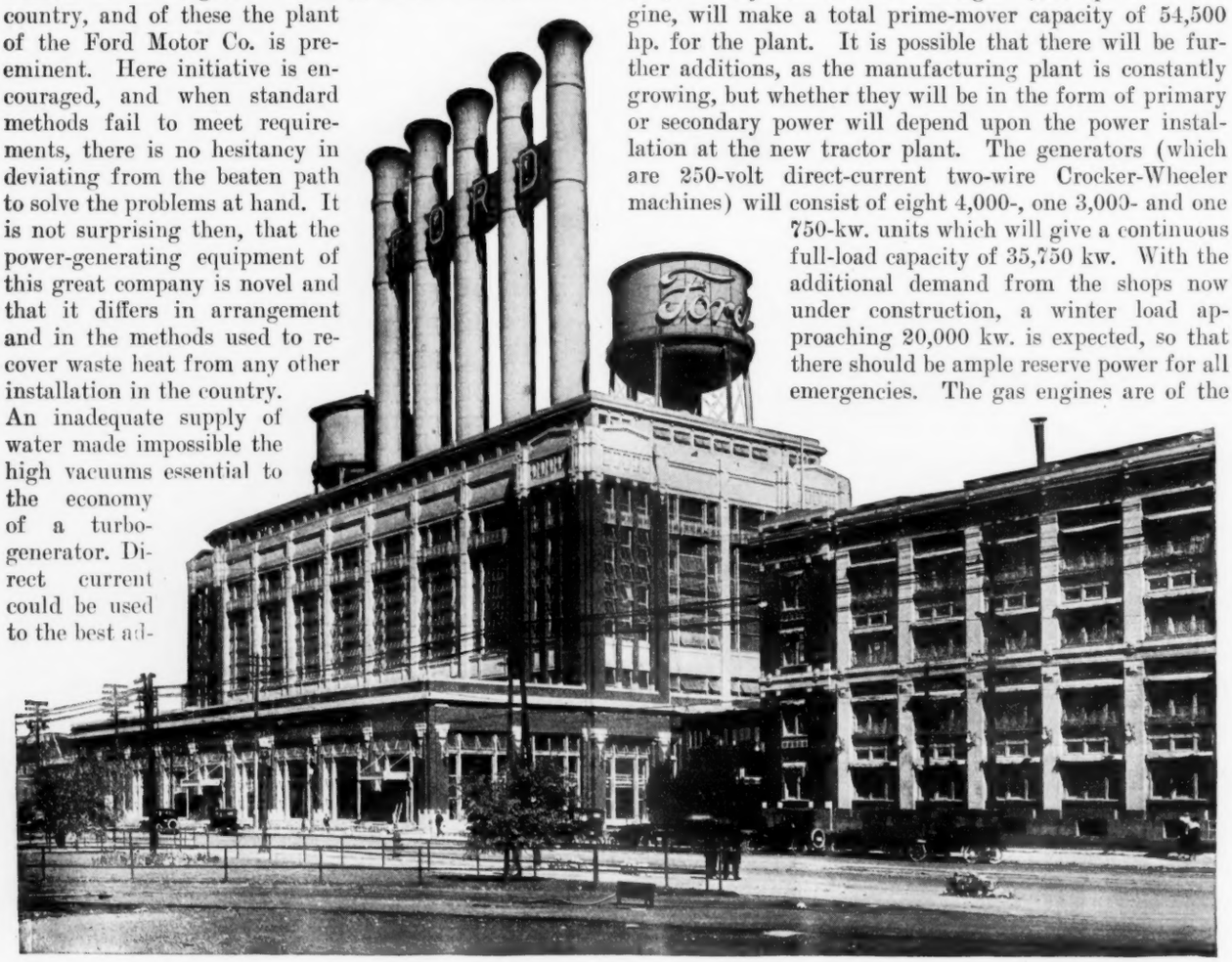


FIG. 1. EXTERIOR OF THE THREE-STORY FORD GAS-STEAM POWER PLANT

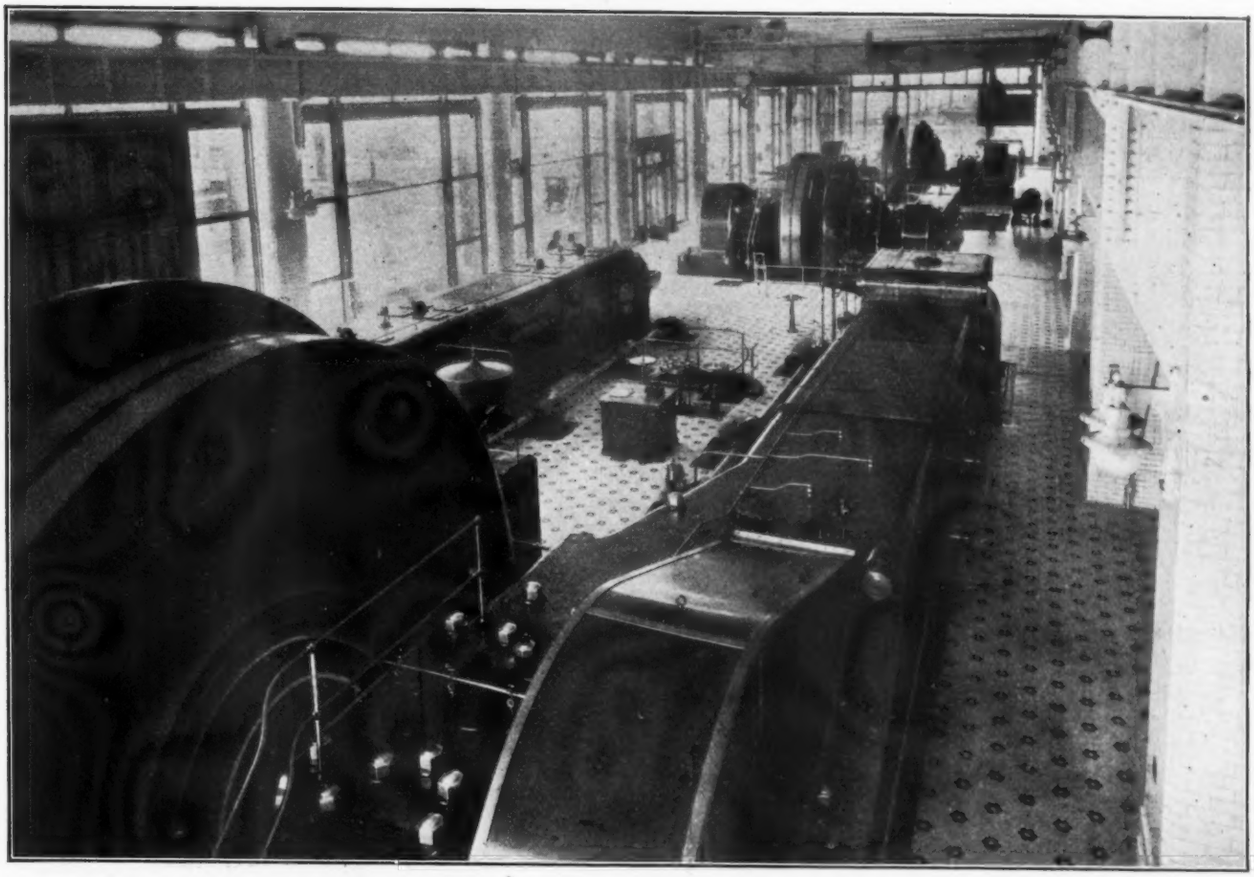


FIG. 2. OUTER BAYS OF THE ENGINE ROOM ON THE WOODWARD AVE. SIDE

FIG. 3. BAYS ON INNER SIDE, SHOWING SWITCHBOARD AND CONDENSER CIRCULATING PUMP IN BACKGROUND

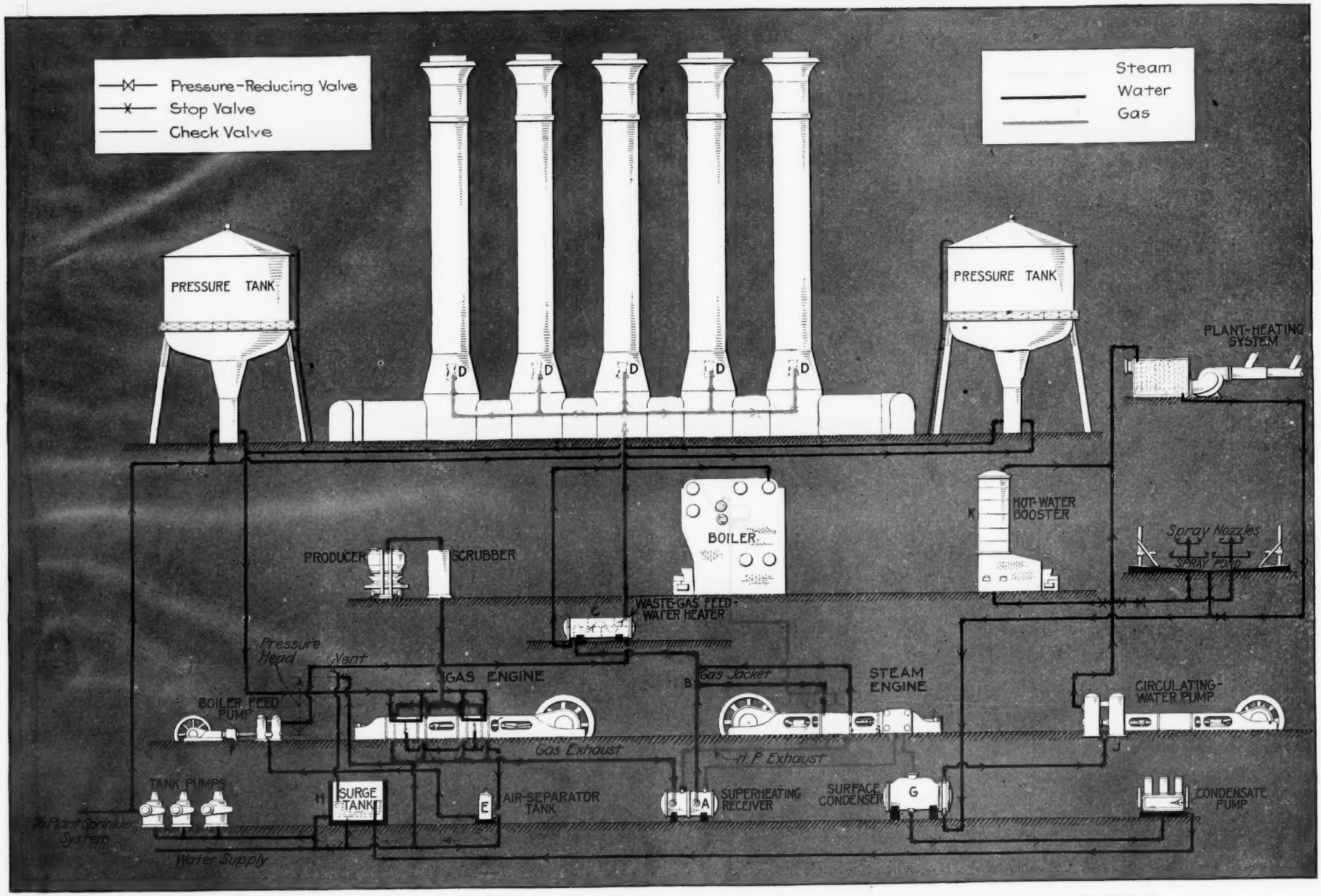


FIG. 4. CYCLE OF OPERATION, TRACING THE FLOW OF THE GAS, STEAM AND WATER, IN THE FORD GAS-STEAM POWER PLANT

straight steam engine has cylinders 30 and 56 by 48 in. The speeds are 80, 85 and 100 r.p.m. respectively. Under ordinary conditions all load possible will be carried on the gas side, but at maximum capacity the load is about equally divided. Owing to the higher thermal efficiency of the gas engine, it is desirable that it should carry the greater proportion of the load and that this load be maintained constant. Under these conditions, the highest efficiency possible is obtained in the gas cylinders and any trouble from tar deposit due to wiredrawing of the gas through the valves at light load is eliminated. The gas engine has a connection to the main governor of the unit, but up to normal speed there is no action, so that the steam engine does all the regulation and meets any fluctuation in the load. Above normal speed the governor throttles the supply of gas and air. Should trouble develop due to inequalities in the gas or to the condition of the igniters, the load is automatically shifted to the steam side, which at late cutoff can handle the entire demand. In the event of the main circuit-breaker opening, provision has been made to stop instantly the production of power on the gas side; this is accomplished by interrupting the ignition circuit through a switch functioning with the circuit-breaker. The gas throttle-control magnet, being on the same circuit, is deënergized, shutting off automatically the supply of gas.

Heat-Saving Processes Employed

How the savings in waste heat and other economies are effected is best explained by tracing the various mediums employed. Their courses are indicated in Fig. 4. Producer gas averaging about 140 B.t.u. is supplied to the gas cylinders. (Follow the red line from the producer through the scrubber to the gas-engine cylinder.) The exhaust passes through a water-cooled discharge pipe to a superheating receiver *A* located between the high- and low-pressure cylinders of the steam engine. The flow of gas and steam is counter-current, so that the maximum exchange of heat takes place. From *B* a part of the gas is shunted through the jacket of the high-pressure steam cylinder, the amount being regulated by hand through a butterfly valve so that a temperature approximating 500 deg. is maintained in the jacket. The shunt connection then leads back to the main exhaust line, from which the gases pass through a feed-water heater *C*, made up of four elements, to the stacks serving the boilers. At the point of discharge an induced-draft device *D* utilizing, on the ejector principle, the residual velocity of the gases has been provided to increase the pull of the stacks which rise 207 ft. above the boiler-room floor.

To avoid the corroding effect of the sulphurous gases the heater tubes are made of "armco" iron. The superheater shell is protected by firebrick, the tube sheets by cast-iron protective plates and the tubes by V-shaped cast-iron fins which practically triple the surface exposed to the gases. In the superheaters for the addition to the plant it is proposed to use ingot iron tubes and a protective coating on other exposed metal.

Cooling water for the jackets, pistons, piston rods and exhaust pipes of the gas engines comes at a temperature of 65 deg. from the pressure tanks on the roof, flowing by gravity through the parts named to an air-separating tank *E* and thence to the feed pump *F*, which forces it through the feed-water heaters *C*, to the boilers. The receiving tank is provided with an air-control valve and an overflow to a 40,000-gal. surge tank *H*, which also receives the condensate from the steam condensers. This water is elevated to the pressure tanks and is available for cooling, fire service and general use. With the jacket water coming from the gas engines at 195 deg. and in sufficient quantity for the boilers, the condensate is not needed, but may be utilized to advantage later on, when the plant has reached its ultimate capacity. Much of the scale-forming matter in the water is precipitated in the cylinder jackets, which have been made readily accessible for cleaning, and in the feed-water heater, so that as boiler feed the cooling water will be almost equivalent in purity to condensate. Although the heaters have not been installed, a rise in feed-water temperature of 80 deg. is expected and an additional rise in temperature will occur in the rear economizer sections of the new boilers.

The Course of the Steam

Steam at 175-lb. gage pressure (190 absolute) superheated to 600 deg. is delivered to the high-pressure cylinder of the steam engine, where radiation and initial condensation are reduced by the use in the jackets of the exhaust from the gas engine. The exhaust steam from the high-pressure cylinder enters the superheating receiver, retaining part of its superheat, which is considerably increased before the steam is discharged to the low-pressure cylinder. By hand control on the low-pressure cutoff the receiver pressure may be varied to suit the load. From the engine the steam passes on to a surface condenser *G*, having 4,900 sq.ft. of surface in $\frac{5}{8}$-in. brass tubes, and as previously stated, the condensate is discharged to the surge tank *H*. An atmospheric relief to the exhaust gas line is provided, and as a protection against possible back firing, since, in case of loss of vacuum the steam engine exhausts into the same pipe through the condenser, the shell of the condenser has been designed to withstand an internal pressure of 80 lb. The circulating-water makeup comes from the pressure tanks. In the summer months the supply is conserved by spray ponds on the roof of the building adjacent to the power plant. The water under a head of 20 lb. flows from the ponds through the condensers to the suctions of two 15,000,000-gal. steam pumps *J*, which force it up through the spray nozzles serving the ponds against a head approximating 45 lb. To get the necessary cooling in hot weather, one-half of the water bypasses the condensers and is returned to the roof to be resprayed. The pumps work against the friction head only, which amounts to about 25 lb. There are now five ponds and plans for three more, each pond having 216 nozzles guaranteed to cool 28 deg. 4,200 gal. of water per minute.

In the heating season the condenser cooling water is to be circulated through a closed hot-water heating system serving the entire plant, the temperature of the water determining the vacuum to be obtained. All direct radiation and indirect coils are sized for an outgoing temperature of 150 deg. in zero weather, which would allow a vacuum in the vicinity of 20 in. in the condenser. In moderate weather the water temperature could be reduced so that a vacuum approaching the normal value of 26 in. would be possible. Roughly, 22,000 gal. of water per minute will be circulated through the heating system and per-

haps a lesser quantity when the air in the buildings is recirculated. Under maximum conditions it is proposed to abstract 25 B.t.u. from each pound of water, which would mean a temperature drop of 25 deg., and return the water at a temperature of 125 deg.

An approximate estimate shows that with the plant operating under normal conditions there will be sufficient steam to maintain the service. In other words, the power and heating loads will nearly balance, producing a condition most favorable to the economy of the steam end of the plant. Should the supply of steam prove inadequate, it is purposed to use the vertical boilers *K*, now supplying high-pressure steam, as boosters to raise the temperature of the water to the desired degree.

Although it is evident that the economy of the composite unit is high, particularly during the heating season, no complete tests have been made that would determine the operating efficiency. In fact, at the present writing the boiler feed-water heaters through which the exhaust gases are to pass have not been installed, the large boilers are still under erection and the hot-water heating system utilizing the steam-condenser circulating water has not been put into service. Only estimates based on some data that are available and reasonable assumptions of what the equipment should do are possible, and these must be taken for what they are worth, as the actual performance can be indicated only by accurate tests under average operating conditions.

Plant and Unit Efficiency

With steam at a temperature of 500 deg. and a pressure of 175 lb. gage at the throttle and with a vacuum of 26 in., the steam engines are guaranteed to develop an indicated horsepower-hour on 10.9 lb. of steam. The water rate should be some what better with the 600 deg., which it is purposed to use. For a reciprocating engine the figure given is exceptionally good, and just how much it will be improved by the jacket of hot gases in the high-pressure cylinder and the superheating of the receiver steam must be determined by test. A fair assumption would be 10 lb. and perhaps less per indicated horsepower-hour. These refinements are of special value in the summer months and the light heating periods during the winter. During the heavy demands by the heating system, economy in the steam engine is not so important, as it is estimated that the demand for steam may exceed the supply, and it is more economical to let it pass through the engine than to operate additional boilers to boost the temperature of the heating water.

For the large boilers now being erected an over-all efficiency of 75 per cent. would not be excessive, so that three-quarters of the energy in the coal would be delivered in the steam to the engine. In the heating season the temperature range of the steam will be from 600 deg. F. and 175 lb. gage pressure at the engine throttle to 150 deg. F. in the condenser. At this lower vacuum the water rate will increase to perhaps 11 lb. Because of the superheating receiver it is probable that the steam will be dry when leaving the low-pressure cylinder. Then deducting the heat in the water at condenser temperature from the total heat in the steam at the engine throttle, multiplying by the pounds of steam per indicated horsepower-hour and dividing 2,545 by the product will give the thermal efficiency of the engine. Thus 1,317 — 117 = 1,200 B.t.u. and 2,545 ÷ (1,200 × 11) = 19.3 per cent. of the heat supplied the engine is utilized in mechanical work or dissipated in engine losses. Assuming that the mechanical efficiency of the engine at full load is 94 per cent. and that of the generator including the loss to the switchboard 95 per cent., then 0.193 × 0.94 × 0.95 = 0.172 = 17.2 per cent. of the energy in the steam, or 12.9 per cent. of the energy of the coal is available at the switchboard.

In the summer months or whenever the engine is operating at full load on 26 in. of vacuum, the water rate is estimated at 10 lb. per indicated horsepower-hour. The thermal efficiency would then be 2,545 ÷ (1,317 — 93) × 10 = 0.208 = 20.8 per cent., and the energy at the switchboard would amount to 0.208 × 0.94 × 0.95 = 0.1857 = 18.57 per cent. of the heat in the steam, or 13.9 per cent. of the heat in the coal.

Effect of the Heating System

The latent heat of the steam at a temperature of 150 deg. F. would be available for heating. This amounts to 1,007 B.t.u. per lb., and allowing a 10 per cent. loss for radiation in the mains outside the buildings leaves 906.3 B.t.u., which is 906.3 ÷ 1,317 = 0.688 = 68.8 per cent. of the energy in the steam, or 52 per cent. of the energy in the coal. Adding the 52 and the 12.9 per cent. gives a total of practically 65 per cent., this percentage of the heat in the coal being utilized during the heating season. This of course depends on a balanced condition between heating and power, and from this deductions must be made for the auxiliaries which are motor-driven and for the large circulating pumps.

From data giving the quantity of gas supplied the cylinders of the gas engine and its heat content, the quantity and temperatures of the jacket water and the temperatures of the exhaust gases, it was computed that 25 per cent. of the energy in the gas was developed into brake horsepower, that 28 per cent. of the heat supplied went to the jackets and 30 per cent. left the cylinders in the exhaust gases. Practically all the jacket water will be utilized in the boilers, so that approximately all this heat will be recovered. From the exhaust gases 6 per cent. of the total heat is recovered in the water-jacketed exhaust pipes and eventually reaches the boilers, 8 per cent. is transferred to the steam in the superheating receiver of the steam engine, and it is expected that another 8 per cent. will be recovered in the heaters.

Nearly 60 Per Cent. of Heat Usefully Applied

With a generator efficiency of 95 per cent. there would then be available at the switchboard 24 per cent. of the energy in the gas, or assuming a producer efficiency of 85 per cent., the electrical energy would amount to 20.4 per cent. of the heat in the coal. The recovered heat totals 50 per cent. of the heat in the gases, or 37 per cent. of the heat in the coal, making a total of 37 + 20.4 = 57.4 per cent. This percentage of the total heat in the coal is utilized, but part of it is so intertwined with the steam system that the over-all efficiency of the entire plant is problematical and hardly open to estimate.

As a résumé it might be stated that the high economy of the gas engine is obtained on at least one-half of the load the year around and that on the other half of the load the economy of an efficient steam system is improved by practically all the heat in the jacket water of the gas engine and three-quarters of the heat in the exhaust gases.

Draft and Its Application to the Steam Boiler

By E. A. Uehling

Draft in its relation to steam boilers is the motive force that causes a current of air to flow, supplying the fuel with the oxygen necessary for combustion, and to propel the products of combustion to the chimney.

The total draft is the difference between the highest pressure of the air supplied and the lowest pressure of the gas on its way to the chimney. The available draft is the difference between the pressure in the ashpit and that immediately behind the damper. Effective draft, the pressure differential between ashpit and damper, is composed of two parts—furnace draft, the resistance through the fire; and boiler draft, the resistance through the boiler—and may be augmented by increasing the pressure of the air under the grate. If the draft is produced by the suction of a chimney alone, it is called natural draft; if produced or augmented by artificial means, it is called mechanical draft. If artificially augmented by pressure in the ashpit, it is called forced draft; if by artificial reduction of pressure between the boiler and the chimney, it is called induced draft. Forced draft may be produced either by a fan blower or by steam jets. Induced draft is also produced by a fan or steam jets, but placed between the boiler and the chimney. In most cases the products of combustion must be carried well above the surrounding buildings, so a chimney is a necessity irrespective of the means employed to produce the required draft.

The chimney is the most common and also the most economical means of producing draft. If properly designed and built and not overburdened by an unnecessary volume of gases and handicapped by undue reduction of temperature, a chimney will produce all the draft required for steady load conditions, but where the requirements for steam are extraordinary and heavy peak loads must be taken care of, chimney draft alone cannot always be relied upon.

Conditions Governing Chimney Draft

The intensity of draft produced by a given chimney increases with the gas temperature and decreases with an increase of weight of gases passing through it in a unit of time, when taxed beyond its normal capacity. To get the best results from a given chimney, all useless reduction of temperature, such as avoidable radiation from the uptakes and flues leading from the boilers to the chimney, and especially leakage of cold air into flues and chimney, must be avoided.

Air leakage reduces the chimney draft in two ways—by reducing the temperature of the gas and by adding to its burden. The term burden means the weight of gas passing through in a unit of time, say one hour. It is composed of a (the weight of combustible burned) plus b (the theoretical weight of air required for complete combustion) plus c (the excess of air required to assure complete combustion) plus x (the weight of air drawn through the fire in excess of that needed to secure complete combustion) plus y (the inleakage of air between the combustion chamber and the damper) plus z (the inleakage air between damper and chimney).

Many chimneys have been condemned as insufficient that would have been ample if not improperly taxed. It is therefore of the greatest importance to know what burden the chimney is carrying. This is readily determined by the percentage of CO_2 in the flue gas at the point of entrance to the chimney. The legitimate burden consists of the factors a, b and c, of which a and b are fixed quantities for any given fuel and c varies with the condition of the fire, manner of stoking, etc., but should be kept at a minimum by keeping the percentage of CO_2 at a maximum, which can be accomplished with certainty only with the aid of a continuous CO_2 meter, under direct observation of the fireman. For diagnosing the flue gases between the boilers and chimney, a simple hand CO_2 apparatus suffices.

To calculate the burden of a chimney, the percentage of CO_2 in gases, the weight of coal burned per hour and the combustible constituents of the coal—that is, the percentages of carbon, hydrogen, sulphur and moisture—must be known. The burden is then determined by the formula,

$$B = \left(\frac{243.6C}{100P} + \frac{C + 9H + 2S + M}{100}\right)W \qquad (1)$$

in which

B = Burden;
P = Percentage of CO_2;
W = Weight of coal burned per hour;
C = Percentage of carbon in the coal;
H = Percentage of hydrogen in the coal;
S = Percentage of sulphur in the coal;
M = Percentage of moisture in the coal.

To illustrate, assume that the coal contains 80 per cent. carbon, 4 per cent. hydrogen, 1.5 per cent. sulphur and 5 per cent. moisture, and that 2,500 lb. is burned per hour. Under good conditions such coal should be completely burned with 40 per cent. excess of air. This would correspond to 12 per cent. of CO_2 in the products of combustion. Inserting these values and that of P into the equation (1) we have:

$$B = \left(\frac{243.6 \times 80}{1{,}200} + \frac{80 + (9 \times 4) + (2 \times 1.5) + 5}{100}\right) \times 2{,}500 = 43{,}700\ lb. \qquad (2)$$

This is the weight of gas to be carried off per hour and constitutes the legitimate burden. It is quite the exception to find an average of 10 per cent. of CO_2 in the chimney, and as low as 3 per cent. is not infrequently met. If the gas in the chimney contains 6 per cent. of CO_2, then designating the resulting burden by B_1, it becomes

$$B_1 = \frac{243.6 \times 80}{600} + \frac{80 + (9 \times 4) + (2 \times 1.5) + 5}{100} \times 2{,}500 = 84{,}300\ lb. \qquad (3)$$

The chimney is loaded with $84{,}300 - 43{,}700 = 40{,}600$, or $\frac{40{,}600 \times 100}{84{,}300} = 92.91$ per cent. of excess burden, composed of the factors x, y and z. That portion of B_1 due to

x and y interferes directly with the efficiency of the boiler, x lessens the heat absorption because it reduces the flame temperature and carries heat to waste, y carries heat away, and all three factors affect the boiler efficiency indirectly by reducing the available draft; while z also reduces the available draft by reducing the chimney temperature.

Assuming that the products of combustion leave the furnace containing 12 per cent. of CO_2 and that by air infiltration (y) and leakage (z) this is reduced to 6 per cent. on reaching the chimney; assuming further that with a perfectly tight boiler setting the gases would leave the boilers with an average temperature (T_b) of 500 deg. and that the temperature of the air (T_a) in the boiler room is 90 deg., then because ($T_c \times B_r$) plus radiation must equal ($T_b \times B$) + $T_a \times (B_r - B)$, from the conditions assumed, neglecting radiation, the chimney temperature would be reduced from 500 deg. to

$$T_c = \frac{500 \times 43{,}700 + 90 \times 40{,}600}{84{,}300} = 303 \textit{ deg.} \quad (4)$$

a reduction of 500 — 303 = 197 deg. due to the air leakage.

Draft intensity, or force of draft, is determined by the formula,

$$F = h\left(\frac{7.64}{r_2} - \frac{7.95}{r_1}\right)^* \quad (5)$$

in which r_1 is the absolute temperature of the external air and r_2 that of the gases in the chimney. Denoting the reduced temperature due to the reduction of CO_2 from 12 per cent. to 6 per cent. as determined by equation (4) by r_3, also in absolute temperature, then

$$D_r = \frac{\left(\frac{7.64}{r_1} - \frac{7.95}{r_2}\right) - \left(\frac{7.64}{r_1} - \frac{7.95}{r_3}\right)}{\frac{7.64}{r_1} - \frac{7.95}{r_2}} \times 100 \quad (6)$$

percentage of draft reduction due to reduction of stack temperature caused by the air leakage assumed. Substituting the absolute temperature values for r_1, r_2 and r_3 in equation (6), we have

$$D_r = \frac{\left(\frac{7.64}{550} - \frac{7.95}{960}\right) - \left(\frac{7.64}{550} - \frac{7.95}{763}\right)}{\frac{7.64}{550} - \frac{7.95}{960}}$$

$$\times 100 = 38.15 \textit{ per cent.}$$

Under the conditions assumed, an increase of 90.68 per cent. of burden to be carried with a 38.15 per cent. draft handicap due to temperature reduction may condemn a chimney that would have been adequate if the percentage of CO_2 had been kept within proper limits. While the effect may be less serious where the chimney draft is ample or where it has been supplemented by mechanical means, it is none the less important because of the cost of operating the fan and increases the weight of gases chased through the boilers and up the chimney.

Theoretically it makes no difference what system or combination of draft systems is employed, so long as the motive force—that is, the available pressure differential—is in excess of the effective draft requirements and air leaks are prevented.

Natural draft may be created by one large chimney serving all the boilers of a given plant, or each boiler or pair of boilers may be served by a separate stack. One large chimney has the advantage over a number of smaller stacks in that it can be built much higher and thus produce a greater pressure differential, but it has the disadvantage of being more apt to be overloaded because of long and leaky smoke flues and leaky dampers of dead boilers.

Chimney draft lacks flexibility and is materially influenced by atmospheric conditions. Boilers placed at high altitudes require larger and higher chimneys than those at or near sea level, because of the lower barometric pressure and density of the air. The barometric variation at sea level may reach 3 in. of mercury (28 to 31 in.) and such a variation would affect the density and hence the effectiveness of the draft, $\frac{(31 - 28) \times 100}{31} = 9.68$ per cent.

Since natural draft depends primarily on the difference of temperature between the gas inside and the air outside of the chimney, it will be affected just as much by temperature changes of the air outside as by changes in temperature of the gas inside the chimney, and the temperature may vary in extreme cases, in the same locality, between 20 and 100 deg. and be a large factor in influencing the natural draft. Assuming the stack temperature as 500 deg. and the temperature outside —20 deg. in one case and 100 deg. in another, by formula (6) there is a possible variation of

$$D_r = \frac{\left(\frac{7.64}{440} - \frac{7.95}{960}\right) - \left(\frac{7.64}{560} - \frac{7.95}{960}\right)}{\frac{7.64}{440} - \frac{7.95}{960}}$$

$$\times 100 = 41.03 \textit{ per cent.}$$

which means that everything else being the same, a chimney would show 41 per cent. greater draft with the thermometer at 20 deg. below zero than when at 100 deg. above.

A fire burns much better in clear, dry weather than on hot, sultry or foggy days. This is due to the water vapor in the air, which retards combustion in two ways, and frequently also to a lower barometric pressure which is apt to prevail under such conditions. This means that the air weighs less per cubic foot and a part of the volume is taken up by the water vapor, which not only displaces so much good air, but absorbs heat and retards combustion within the fuel bed.

Air at 92 deg. and 75 per cent. saturation, which is not uncommon, contains 2.5 per cent. by weight of water vapor. The specific weight of water vapor is 0.62, hence it displaces $\frac{2.5}{0.62} = 4.66$ per cent. dry air by volume. Add to this the effect of higher temperature and low barometer, which are so often coexistent with high humidity, and the reason for slow combustion becomes evident.

The effect of a brisk wind in the right direction is well known, although its influence cannot be even approximately calculated beforehand.

The variations in the atmosphere rarely occur to the full extent and probably never at the same time, and one condition may largely neutralize the other; nevertheless natural draft is greatly affected by atmospheric conditions.

Mechanical draft is also affected by the state of the atmosphere, but the deficiency can be supplied by increasing the speed of the fan or blower.

*Kent, page 945.

Induced draft is in its effect the same as exaggerated chimney draft, and its advantage is that it may be increased beyond that possible with a chimney, but unless carefully regulated to the minimum required, will draw large quantities of air through cracks and crevices, thus not only adding to its load, but chilling the gases in their passage through the boiler and the economizer, if one is used. Induced draft may become a necessity with an economizer and furnishes the only good excuse for its employment. The advantage that stands to the credit of induced draft is that the products of combustion can be crowded through a chimney that would be entirely too small if either natural or forced draft was used.

Forced draft differs from natural and induced draft in that it is positive in its action, whereas the latter may be considered as acting negatively. Forced draft delivers the air to the fire under a pressure greater than that of the atmosphere and has several great advantages, namely: (1) The fires can be forced to any desirable degree; (2) low-grade fuel, such as anthracite, buckwheat, rice and culm and bituminous slack and screenings can be burned with good results; (3) the pressure differential between the outside atmosphere and that within the furnace can be kept at a minimum, thus reducing air infiltration, even when the boiler setting is not tight.

Forced Draft Systems Described

There are three systems of forced draft, as follows:

1. The single-unit system in which one fan or blower serves a number of boilers through an air duct connected with the ashpits and provided with dampers for regulating the flow of air to each. This system has the disadvantage of high cost of installation, which, however, is compensated for to some extent by low operating costs and the fact that it can be automatically regulated by the steam pressure. This, however, is a debatable point and will be taken up later.

2. The individual blower system, in which each boiler is furnished with a separate blower, consists of a steam or electric driven propeller fan that can be regulated to the necessary speed. Blowers of this system have the advantage of being self-contained in a metal case, are readily attached to any boiler and are low in first cost. They are easily regulated and can be shut off when not needed. They have the disadvantage of higher steam consumption, and they are apt to speed up with increasing steam pressure unless automatically regulated, which is contrary to the requirement. For small plants they are probably the best, having many points in their favor.

3. The steam-jet blower system, in which a large number of fine steam jets are employed to impel the air into the ashpit. While it is theoretically all wrong to burn fuel with a mixture of air and steam, yet there are conditions under which the steam blower can be used to advantage. In burning low-grade coal containing a high percentage of easily fusible earthy matter, it is no doubt the right thing to use. Its low first cost makes its installation attractive, but the high steam consumption, together with the wasteful effect of the steam, bars its use except where very cheap low-grade coal is available.

Furnace draft varies with the desired rate of combustion and the ever-changing conditions of the fire bed. The furnace draft required to burn a definite weight of coal per square foot of grate area depends (a) on the construction and condition of the grate bars, (b) the kind of coal, (c) the physical condition of the coal, (d) the thickness and evenness of the fire, (e) the thickness and condition of the ash bed, presence or absence of clinker, etc. Some of the factors of resistance vary from minute to minute, others from hour to hour, so that a constant furnace draft cannot be depended on to produce a constant rate of combustion.

Boiler draft, on the other hand, is practically a constant for a given rate of combustion, provided the percentage of CO_2 in the products of combustion is held within proper limits. Its magnitude depends on (a) the type of boiler, (b) the area of the gas passages through the boiler, (c) the arrangement of baffling, and (d) the volume of gas produced per pound of fuel burned. Since the volume of gas varies, almost inversely as the percentage of CO_2 it contains, it follows that if the latter is kept constant, the boiler draft becomes a true index to the rate of combustion, because the factors a, b and c are fixed for any given boiler.

Effective draft being composed of two factors, one of which is variable, it is evident that frequent adjustments of the damper are necessary not only for a variable, but also for a constant demand for steam; therefore, a draft gage showing only the total effective draft is of little use as a guide to high efficiency in regulating combustion. The fireman must have under constant observation the steam pressure, the percentage of CO_2 and the boiler draft.

Operating Conditions Shown by Draft

The boiler draft is not only an index to the rate of steaming, showing whether each boiler is doing its full share of the work, but it immediately detects broken-down baffling or other causes short-circuiting the gas. In addition to a CO_2 and a boiler-draft indicator, means should also be provided by which the fireman can see or at least readily diagnose the furnace draft. There are a number of compound differential-draft indicators on the market that indicate the effective draft and the furnace draft in juxtaposition, allowing the boiler draft to be read off by difference, thus giving complete draft information. Their usefulness is overrated, however, when it is claimed that their showing can be used as an index of combustion efficiency.

Balanced draft is in reality a misnomer, since a sufficient unbalance must be maintained to force the air required for combustion through the fire and the products of combustion through the boiler, no matter how the motive force producing the effective draft is applied. Balanced draft is a condition where the pressure in the ashpit is just sufficient to overcome the resistance through the fire and the damper is so regulated that the chimney will draw the products of combustion through the boiler without creating a vacuum in the furnace. In other words, when the furnace draft is supplied by a blower and the boiler draft is created by a fan or chimney, we have a draft condition which results in atmospheric pressure in the furnace.

Theoretically there is no advantage in balanced draft, but practically it has several points in its favor: It prevents the inrush of cold air into the furnace while the doors are open and it reduces air infiltration to a minimum.

Draft regulation is one of the most important, yet one of the most neglected, factors in the operation of boilers.

Warped and inoperative dampers are the rule rather than the exception. Regulating combustion by the ashpit doors, and the malpractice of throwing the furnace doors ajar to check excessive steaming are by no means rare. That this must result in low efficiency is self-evident. One damper in the main chimney flue serving a battery of boilers is not good practice. Each individual boiler should be provided with a damper so rigged that it can be handily manipulated by the fireman at or near the boiler front within plain view of the draft gages and CO_2 indicator.

Automatic draft regulation has found wide application and serves excellently in maintaining an even steam pressure, but whether it is conducive to the maintenance of maximum boiler efficiency is questionable. Since the resistance through the fire varies continually, it follows that no two boilers will ever be quite alike in their draft requirements, so that one will be getting too much and the other too little air at times, which may result in very low CO_2 in one and incomplete combustion in the other. Too much automaticity also tends to reduce the vigilance of the boiler-room force as well as their sense of responsibility.

Vincent Automatic Drain Valve

The Vincent automatic drain valve, made by the Canadian Vincent Valve Co., Ltd., Victoria, B. C., is attached to the steam cylinder of an engine and pump at the ordinary drain connections. It is automatic in the operation of draining the cylinder of water and does away

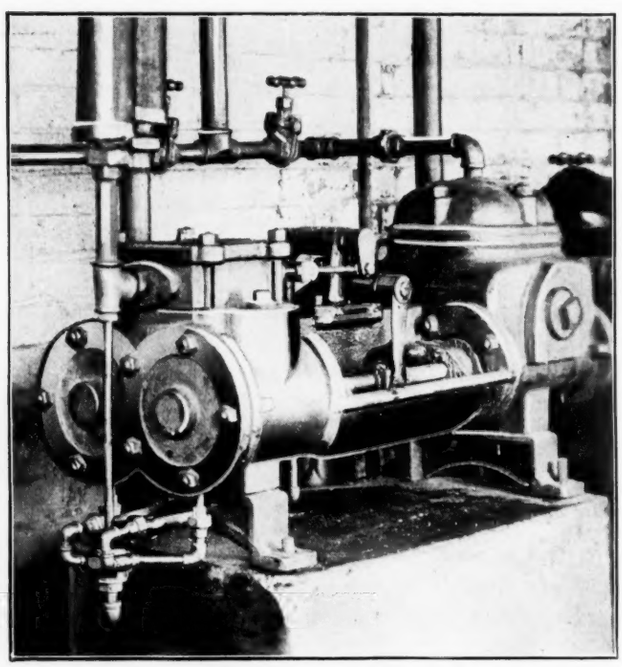


FIG. 1. AUTOMATIC DRAIN VALVE PIPED TO A DUPLEX PUMP

with drain valves that have to be operated by hand. As soon as steam is shut off from the engine or pump, the valve opens the cylinder drains and they remain open until the engine is again started and dry steam reaches the valve. Fig. 1 shows the piping of the drain valve attached to a duplex pump. Water under any pressure does not close the valve, and in the event of water flowing ahead of the steam in starting the engine, the valve will remain open until dry steam reaches and closes it.

A high-pressure steam connection is run to the steam chest or to a point between the steam chest and the throttle. A bottom connection is for a waste pipe. The

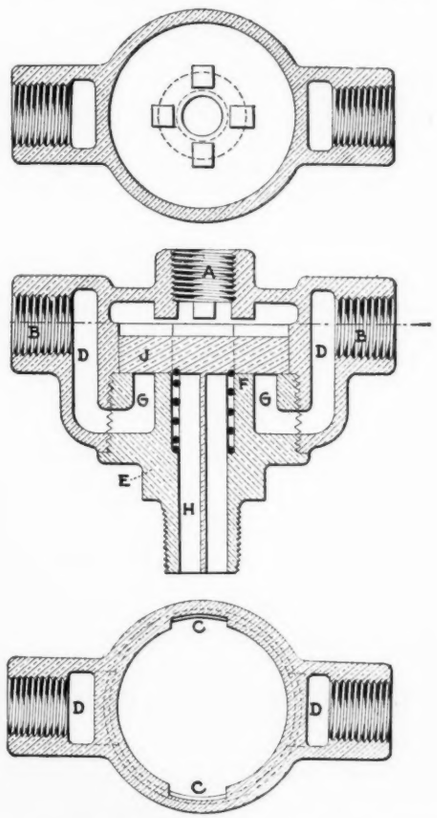


FIG. 2. DETAILS OF THE VALVE CONSTRUCTION

valve is operated by a spring, which raises the valve disk when the throttle is closed and the steam pressure in the valve over the disk is relieved.

Details of construction and operation are as follows: The valve body is made with a pipe connection *A* (see Fig. 2) to the steam chest of the engine. Two low-pressure connections *B* go to the cylinder drains. By-passes *C* on the inside of the high-pressure steam chamber allow condensation from the steam chest to escape past the open valve. Ports *D* connect the low-pressure connection with corresponding passages *G* in the plug or inner member, *E*. This plug is made with a flat valve seat *F*. A waste port and spring well *H* contains the spring that opens the valve disk *J* when the steam is shut off from its upper side, and provides for the escape of water. The condensate flows from the engine cylinder through the ports *D* and *G* across the valve seat *F* and out through the waste port *H*. The valve disk, Fig. 2, is shown closed as when steam pressure is on top.

If, when running, water should come over into the engine cylinder in such quantities as to cause knocking, it is forced out through the drain pipes connecting with *B* and then through the passages *D* and *G* against the under side of the valve disk. This water-hammer, with the assistance of the spring tension, forces the valve disk to lift against the cushion of steam on the upper side of the valve and allows the water to escape through the waste port *H*.

Practical Talks on Controllers--Types of D.-C. Contactors*

SYNOPSIS—This, the fifth article on controllers, treats of some of the different types of direct-current contactors, the function of the blowout coil and the operation of a controller employing shunt contactors equipped with series-current-limit interlocks.

According to the United States statistics, the number of motors in use increased ten times between 1899 and 1909, while the amount of electrical power generated only doubled. This rapid increase in the application of electric motors for the needs of industrial work was due in a large measure to the successful control of these motors by means of industrial-control devices. The construction and operation of some of these that are today being built by the General Electric Co. will be described.

In the early stages of the electric motor knife-blade lever switches were sufficient for their control, but as their application multiplied and their sizes increased, a need for a device that could control more power with less physical effort became necessary. A simple magnetically operated switch, or shunt-type contactor, as shown in Fig. 4, was designed to meet this need.

There resulted two distinct types of contactors—those for use on alternating-current and those for use on direct-current circuits. Only the direct-current type will be considered at this time. Figs. 1 to 3 are side views of a 150-amp. 600-volt single-pole shunt-type direct-current contactor with one side of the arc chute *F* removed so as to expose the contactor parts.

It will be seen from the figures that a contactor is a combination of two things—a magnet and an electric switch. For simplicity we will consider these two factors separately. Referring to Figs. 1 and 2, *A*, *B*, *C* and *J* show respectively the core, frame, armature and exciting coil of the magnet. When the exciting coil *J* is energized by connecting its terminals across the line potential, the armature *C* is attracted and drawn toward the core. When the armature is within about ⅛ in. of it, the contact fingers *D* touch, as shown in Fig. 3. As can be seen in the figure, the contact finger which is connected to the armature is held in position by a spring *G*. Since the attraction or pull between the core and armature is inversely proportional to the square of the air gap *K*, the available pull of the armature in this position is sufficient to compress the spring *G* and thereby hold the two contact tips together under heavy pressure. When the coil is deënergized, this spring causes the contactor to open quickly and assume the position shown in Figs. 1 and 2.

Since under some conditions the supply voltage is far from constant, sometimes varying approximately from 20 per cent. below to 10 per cent. above the rated value, the contactor-energizing coil must be able to operate successfully over this variation in voltage. It is quite a temptation to designers to overwork or overrate an energizing coil during its operating cycle and then automatically insert resistance in circuit after the contactor has closed, in order to keep the coil from overheating. The main objection to this is that the resistance must be inserted just before the armature has completed its travel or sealed and this added resistance may prevent it from sealing and thus cause the main contact tips to overheat or weld. The shunt contactors that are shown in Figs. 4 and 5 are so designed that they will operate continuously on the motor voltage without the insertion of any resistance after the contactor has closed.

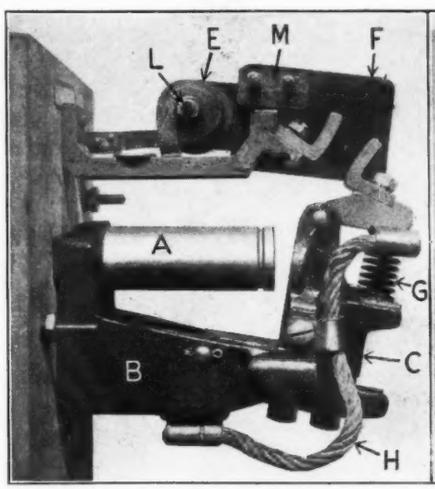


FIG. 1. PARTS OF SHUNT CONTACTOR

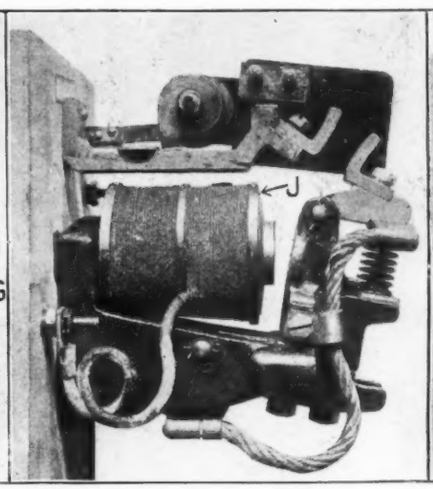


FIG. 2. MAGNET COIL IN PLACE

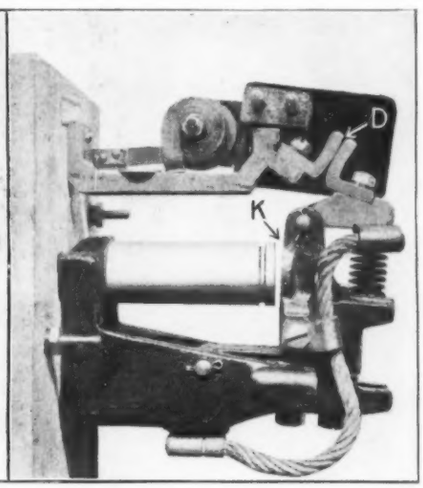


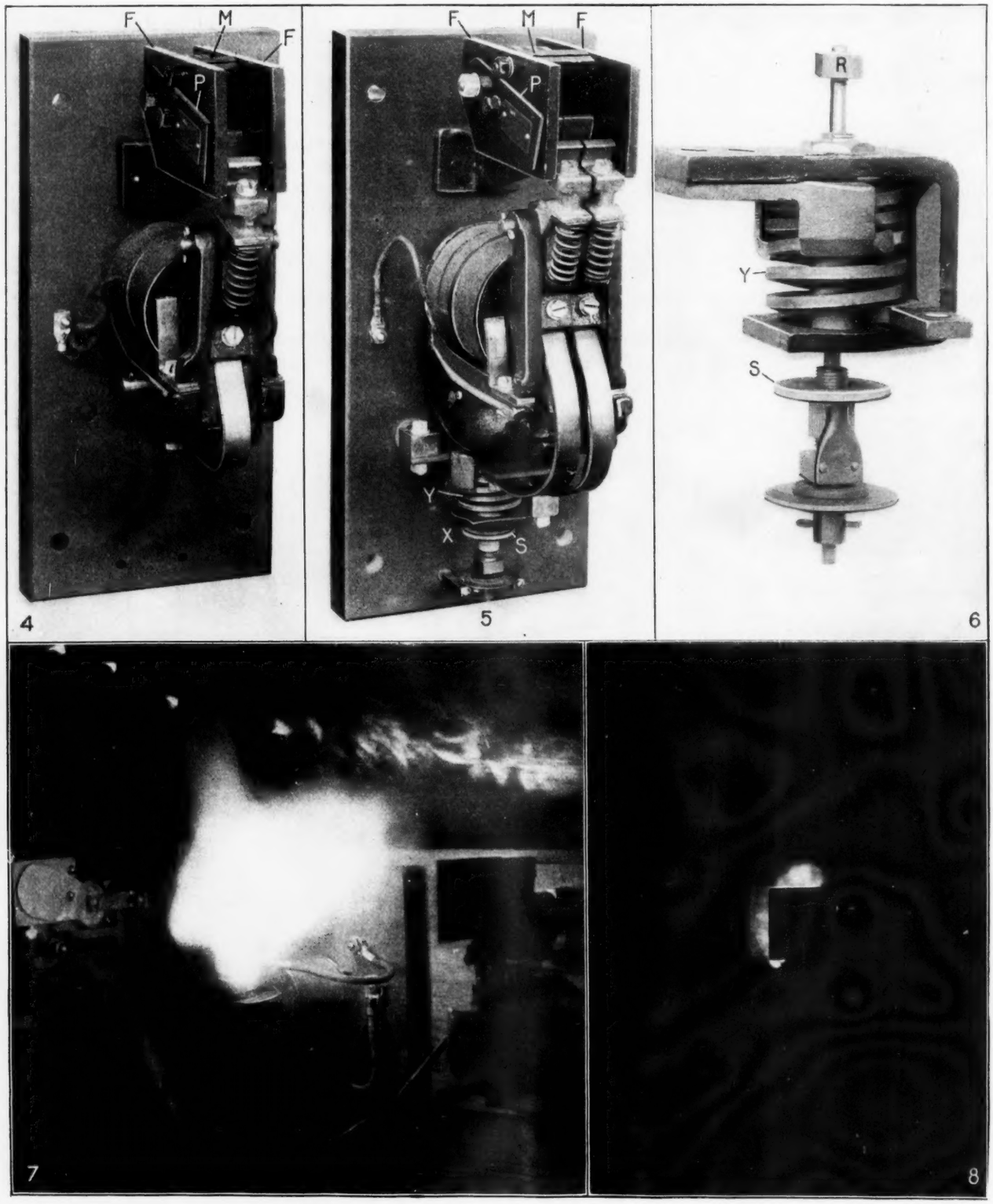
FIG. 3. CONTACTOR CLOSED

Figs. 1 to 3 plainly show how the connections are made from each of the two contact tips *D*, to the back of the panel or slate on which they are mounted. These contact tips are made of copper. It is a well-known fact that if two pieces of copper make a butt contact, they are likely to weld, or freeze, if a very large current is allowed to flow at the instant of contact. Also, the contact surfaces will roughen at both making and breaking and may cause excessive heating, which would lessen their continuous

*The material in this article was contributed by B. W. Jones, of the General Electric Co.

current-carrying capacity. To eliminate these two objectionable features, the copper tips are given a rounding face, as shown in Figs. 1 to 3. Fig. 3 shows that the initial contact is made at the upper part of the tips. When the armature seals, or fully closes, the point of contact will shift by a rolling motion to the lower part of the tips. If these tips should freeze owing to a very heavy inrush of current (5 or 6 times the current rating of the tips), the freeze would be broken by means of the rolling motion, which produces a powerful leverage action.

Therefore this style of contact accomplishes two very important things: First, the initial contact and final break



FIGS. 4 TO 8. TYPES OF SHUNT CONTACTORS AND THE EFFECT OF A BLOWOUT COIL

Fig. 4—Direct-current shunt contactor. Fig. 5—Shunt contactor equipped with a series interlock. Fig. 6—Series interlock. Fig. 7—Shows a shunt contactor without a blowout coil opening an electric circuit. Fig. 8—The same as Fig. 7 equipped with an effective blowout coil.

are made at one point and the final contact, which carries the current while the contactor is closed, is made at a different point on the tips; and second, the rolling motion will break any freeze, or weld, that might take place because of abnormal currents at the instant of contact. Copper contacts have proved their superiority for frequent and hard service over other types of tips.

When the operating coil is deënergized, the contact tips will separate and an electric arc will form between them. The quicker this arc is broken the less burning action there will be. This arc can be broken or ruptured in two ways: By allowing the heated air to rise and force the arc upward, or by greatly augmenting the first method by a strong magnetic field. The first method is slow and allows sufficient time for the conducting vapor and contact parts to become hot, thus making it necessary to draw out the arc to an excessive length before it ruptures. Fig. 7 plainly illustrates this action. It should be noted that the arc started between the tips and gradually rose to the maximum height. The second method immediately forces the arc upward and elongates it before the conducting vapor and contact parts have time to become heated. Therefore the arc is broken sooner and is much shorter. Fig. 8 illustrates this. Figs. 7 and 8 are photographs of tests under the same conditions of current and voltage. Fig. 7 shows the results obtained when no blowout is used. A comparison of this figure with Fig. 8, where a blowout coil is used, shows the marked improvement gained by the use of the latter.

Magnetic Blowout Explained

A simple explanation of the law governing this magnetic blowout will be given. Figs. 1 to 3 show a side view of the contacts *D*, blowout coil *E*, soft-iron magnetic core *L*, arc-chute wall *F* and baffle plate *M*. Another arc-chute wall belongs on the side nearest the observer. It was removed to expose the various parts for these photographs. The arc-chute walls are used to keep the arc from any metallic parts. On the outside of the two arc-chute walls there are sheet-steel polepieces which extend from the soft-iron core *L* slightly beyond the contact tips. These are shown at *P* on the shunt contactors in Figs. 4 and 5. They serve as conductors for the magnetic lines of force from the soft-iron core *L*, or electromagnet, and concentrate them across the path of the arc.

Assume that the current comes in at the top of the contactor, Figs. 1 to 3, through the blowout coil *E*, the contact tips *D*, and out through the flexible shunt *H* to the back of the panel. Applying the well-known right-hand screw rule for determining the polarity of *L*, it will be seen that the direction of the magnetic lines of force across between the polepieces and the direction of the magnetic lines of force caused by the flow of the current through the contact tips will be as represented in Fig. 9, which gives a front view of the contactor arc chute. The end of *L* in Fig. 3 nearest the observer will be the north pole of the electromagnet, and therefore the left-hand polepiece in Fig. 9 will be of north polarity. Consequently the lines of magnetic force which emanate from *N* will pass across between the two polepieces from left to right. The current and its accompanying magnetic field are represented by circles and arrowheads. The combination of the two fields will produce a result as shown in the figure, consequently an upward force is exerted on the current path. Therefore, when the two contact tips are separated and an arc is formed, this magnetic tension immediately forces the current upward very rapidly and so lengthens its path that it is ruptured before the tips and surrounding air have time to become heated.

If the current reverses in the circuit, both the magnetic field and the direction of the current in the arc are reversed and the resultant effect will be the same. However, if either the field or the direction of the current in the arc becomes reversed separately, the arc will be forced downward into the body of the contactor. This may happen, and the defect can be remedied by reversing the blowout coil connections.

In starting up the larger sizes of direct-current motors, a starting resistance is used which is gradually cut out as the motor comes up to speed. A dial switch may be used for this purpose, but contactors are peculiarly suitable because of the ease with which they can be controlled and the large currents which they can satisfactorily handle. However, the speed with which these accelerating contactors close depends entirely upon how fast the operator turns his controlling handle, and thus unskilled or careless operators could severely punish the motor by cutting out the accelerating resistance too rapidly. Therefore a need arose for some device that would prevent the accelerating contactors from being closed faster than the motor could properly accelerate.

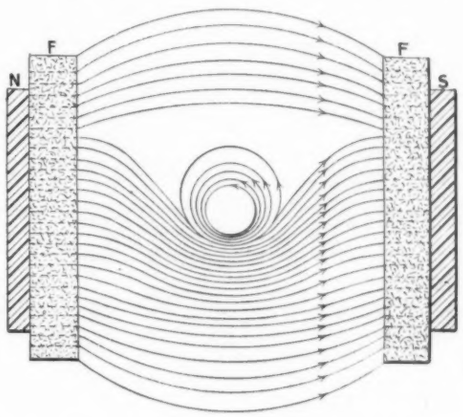


FIG. 9. ACTION OF AN ELECTRIC CURRENT IN A MAGNETIC FIELD

Fig. 6 shows an appliance that was designed to meet this requirement and is known as a series-current-limit interlock. It is fastened to the under part of the contactor, as shown at *X* in Fig. 5, and is operated jointly by means of the series copper coil, as shown, and a tailpiece on the armature of the accelerating contactor, not shown. The series coil consists of six turns with a tap from the center to the movable contact tip. The tailpiece of the accelerating contactor engages the under part of the collar *R*, Fig. 6, which is fastened to the top of the vertical brass stem and holds the interlock up when the contactor is open. The motor current must flow through the six turns of the interlock coil *Y* until the main contact tips touch. Therefore, when the contactor armature begins to close the interlock stem is released, but the ampere turns in the six turns are sufficient to hold it against gravity. When the contact tips touch, the motor current will be diverted down through the contactor and through only three turns of the interlock coil, which would just allow the interlock to drop but for the fact that, when the contact tips touched

they shorted a block of starting resistance, which caused the current to immediately increase. Thus the motor must still further increase in speed before the interlock can drop and complete the circuit for the operating coil of the next accelerating contactor. This action is repeated until all the accelerating contactors have closed. By means of this simple, yet effective, device, the motor is protected from the abuse of the operator. The current at which this interlock drops can be adjusted by turning the knurled adjusting nut S so as to increase or decrease the magnetic air gap.

In Fig. 10 is shown a simple connection diagram which employs these current-limit interlocks to give automatic acceleration of the motor. This shows a compound-wound motor controlled by means of a nonreversing contactor panel having seven contactors and a field rheostat for varying the speed of the motor. The closing of the contactors is controlled by one shunt-wound and five series-wound current-limit relays.

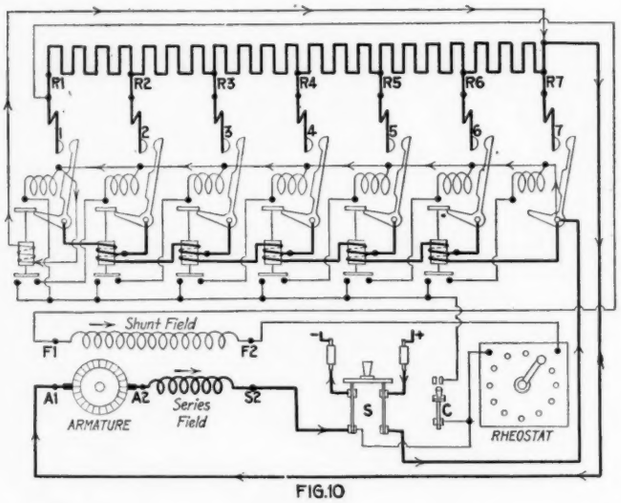


FIG.10

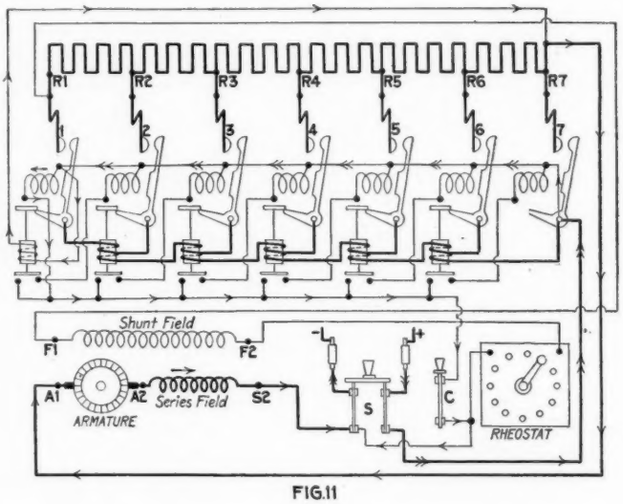


FIG.11

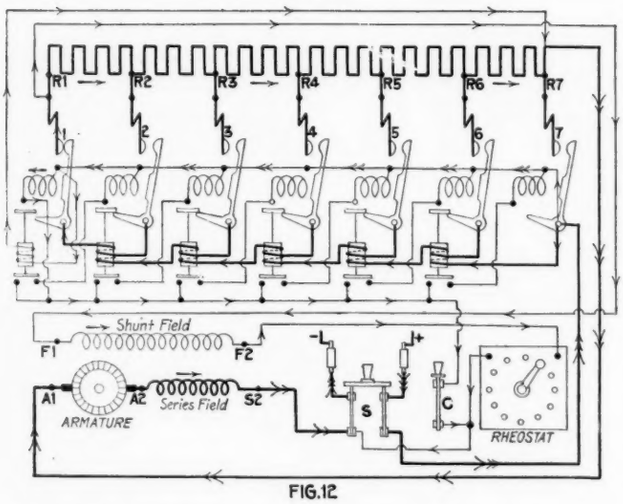


FIG.12

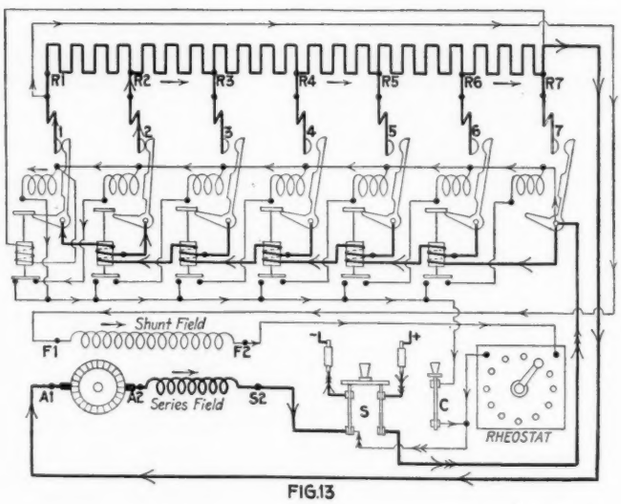


FIG.13

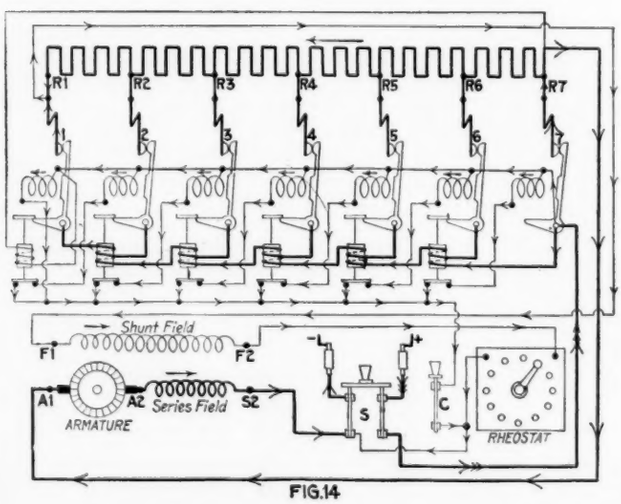


FIG.14

FIGS. 10 TO 14. WIRING DIAGRAMS OF AN AUTOMATIC CONTROLLER USING SERIES INTERLOCKS

The operation of the panel is as follows: Closing the main-line switch S, Fig. 10, puts practically line voltage across the shunt-wound current-limit-interlock coil on the bottom of contactor No. 1 (the direction of the current is indicated by the arrowheads). The single-pole control switch C is closed next, as shown in Fig. 11. Current then flows through No. 1 contact magnet coil. The direction of the current is also shown by the arrowheads. The result is the immediate closing of No. 1 contactor, as shown in Fig. 12, and the resistance allows 150 per cent. motor current to flow. The armature and field circuits are indicated by the arrowheads. Since the shunt-current-limit interlock that is attached to No. 1 contactor is connected directly across $R1$ and $R7$, it still has line voltage, minus the IR drop in the armature across it. This will

not allow the interlock plunger to drop until the motor has partly accelerated and the current decreased to 100 per cent., at which point the voltage across the relay coil is not sufficient to hold the plunger up. At this 100 per cent. current value the plunger drops and makes a circuit for No. 2 contactor coil, as indicated in Fig. 13, and this contactor closes. While it is closing, the 100 per cent. current is still flowing through the six turns of the current-limit interlock of No. 2 contactor, and this produces sufficient ampere turns to prevent the interlock from dropping while the contactor is closing. When the contact tips of No. 2 contactor touch, they short-circuit the section of resistance between $R1$ and $R2$ and three turns of the interlock coil, causing the current to flow through only three turns of this coil up through the contactor and across from $R2$ to $R7$, as indicated by the arrowheads. With this connection of three turns and 100 per cent. current, the interlock would be just at the point of dropping, but a section of the resistance has just been shorted and the current immediately rises to 150 per cent. Thus the interlock on No. 2 contactor is prevented from dropping until the motor accelerates sufficiently to again reduce the current to 100 per cent., when it drops and contactor No. 3 closes. Thus the sequence is continued until all the starting resistance is short-circuited, as in Fig. 14.

To stop the motor, the control switch C is opened, thus deënergizing all the contactors, which open and disconnect the motor from the line.

Features of Other Contactors

The simple shunt contactor, with its current-limit interlock and the method of its application to motors, has been described, but there are a great many different types which have been designed to meet the ever-progressing industrial requirements. In the simple shunt type they are designed in sizes from 20 to 1,500 amp. for use with various sizes of motors, and all but a few of the smallest have arc chutes. For some kinds of work, such as motor reversal, the double-pole contactor is useful, while the double-throw type is used almost exclusively for dynamic braking a motor from full speed to rest, the lower contact closing by gravity. There is a line of series contactors none of which have arc chutes and which range in capacity from 75 to 500 amp. They are used for accelerating a motor, but not for connecting it to or disconnecting it from the line, where a heavy arc might be formed. They combine in one contactor the functions of both the shunt contactor and series-current-limit interlock. A description of their design and operating characteristics will be given in a later issue.

Within the last ten years the requirements of industrial work have become very exacting as well as complicated, and we no longer have the simple problem of starting a motor under a definite load at which it will run for a considerable time. Each line of work has its peculiar characteristics, and the control must meet those requirements if it is to be successful. By properly adjusting the current-limit relays and correctly proportioning the several blocks of resistors, one has gone a long way toward meeting the requirements. But the requirement may be to start and stop once every two seconds; it may be to start and regulate the speed; it may be to use the motor for hoisting a heavy load and then employ the same motor to hold back while lowering, to prevent the load from going down too fast; or it may be to perform numerous other duties having either slow or rapid cycles. Contactors can be designed that are capable of accomplishing any of these requirements when they are correctly connected, properly adjusted and the resistors rightly proportioned.

Electric Power Machinery in France After the War

By Ludwig W. Schmidt

The demand for power in France by industries, especially those employed on government work, since the outbreak of the war has been met without difficulty. While the requirement for electrical energy for industrial work has been increased, there has been a decrease in the demand for lighting purposes and tramways. All the large cities have reduced their local lighting arrangement and are using less power than before. Business, therefore, while it is certainly not normal, is far from bad and in some parts of the country is even better than before the war.

One of the results of the war will be the industrial reawakening of France. *La Revue Electrique*, of 1915, contains two articles of great importance to the future development of power distribution and its application in France after the war. One deals with the use of electrical and other motive power in small industries; the other treats the same question with regard to French agriculture. France, although a large industrial producer, can hardly be said to be highly developed industrially. While a good deal of the national wealth is derived from the operation of her industries, she cannot be compared with such highly developed countries as Germany and England. French artisans before the war did not feel inclined to spend much money on labor-saving devices and machinery nor did the small and medium-sized manufacturers. Motors, especially small ones, are seldom employed. The change foreshadowed by the articles in question should be of great interest to the American engineers employed in power production or the making of power machines.

The destruction of human motor power will make necessary in all European countries its replacement by mechanical power. France is no exception to this rule; in fact, the lack of men may be felt more there than anywhere else, as France before the war had relied more than England or Germany on the working power of her artisans. This is fully realized in France, and French economists and engineers have begun to study how to counteract this unavoidable result of the war by a larger use of mechanical power.

France, it is said, has a large number of small industries which, until now, were practically all manually operated. It has been estimated that the production of these industries could be increased 50 per cent. and more by the simple expedient of employing motive power and suitable machinery. The country, therefore, will benefit greatly if by using motive power and machinery she can raise her own production to such a standard that it can compete in price with the machine work of other countries, while still retaining that French character which is so great a factor in selling French goods.

An educational campaign will have to be carried on; this will cost, but it will obtain the support not only of the

electrical industry and electrical associations, but also of the government. Furthermore, the prejudices of the workers themselves will have to be overcome, as machine work is not liked by the average French workman; but it is certain that an increase in the use of motor power will be one of the factors in the upbuilding of France.

For the beginning the existing power houses will be sufficient. The power supply of France, in general, will have to be increased. So far no organized steps have been taken to study the question; at least nothing is known about any such enterprise. In the south there would be little difficulty in supplying power to a wide part of France at low cost. Here water and steam power are available. The problem seems to be more complicated in the north, and it is likely that a number of new power stations will have to be erected. The formation of local power companies run on a coöperative basis has been suggested. The whole question has won a new interest from the proposition made during a recent economic conference in Paris. It was proposed during this meeting of diplomats and commercial representatives of the allied powers that a closer economic alliance be formed after the war, so as to facilitate the exchange of trade to the possible exclusion of their present opponents. This would make it impossible for Germany to carry on her large business in electrical appliances and machines in France. The question arises, "Would another country be able to take her place?" Any popularization of the use of motive power for agricultural and industrial purposes undoubtedly would greatly increase the demand for dynamos, electrical appliances, motors and electric-light fixtures. To make this supply cheap, greater standardization than today would be necessary. French engineers, therefore, have been discussing the question of a better standardization of supplies. In all these discussions the metric unit is used, which gives a certain advantage to those countries using this unit, including Germany. On the other hand, England, the country with whom the closer economic alliance is desired, uses the inch. This fact, while not an unsurmountable obstacle, is certainly an impediment. The same applies to this country. Our exports of electrical machinery to France reached $180,000 during the last year before the war and were on the increase. Therefore any development in the use of the metric system deserves the attention of the American manufacturer.

The prospect of business in France after the war seems to be very promising. The erection of new power stations can hardly be done without the buying of additional machinery, of which a great part will have to be imported. It is likely that America will receive part of the orders which will come into the market, and a study of this market is therefore advisable.

A Vernier Scale is an auxiliary scale superimposed on a main scale to facilitate the accurate reading of linear or angular measures. Suppose a scale of inches is graduated to tenths and a small scale, the vernier, has ten of its subdivisions equal to nine of the small divisions (tenths) of the principal scale. It is evident that each division of a vernier is smaller than each division of the scale by one-tenth of that division, the difference in the two scales being one-hundredth of an inch. To use the instrument the vernier must be slid along parallel to the scale until its zero line comes opposite the position or point to be measured to. The eye is then run up the scale to see which graduation on the vernier is exactly opposite a graduation on the scale. The number of this graduation on the vernier gives the number of hundredths above the last-observed tenth.

Protecto Ammonia Helmet

Fig. 1 shows an ammonia helmet (Protecto Safety Appliance Co., 444 North 12th St., Newark, N. J.) for use in ammonia fumes. The hood is made of goatskin

FIG. 1. THE PROTECTO AMMONIA HELMET

and has a mouth and nose mask within so as to seal tight with a pneumatic cushion the mouth and nose. The weight of the helmet as worn is 3¾ lb., aëro metal being used where metallic parts are needed.

The air for breathing is taken through the "can" which (see Fig. 2) contains a cartridge filled with chemically

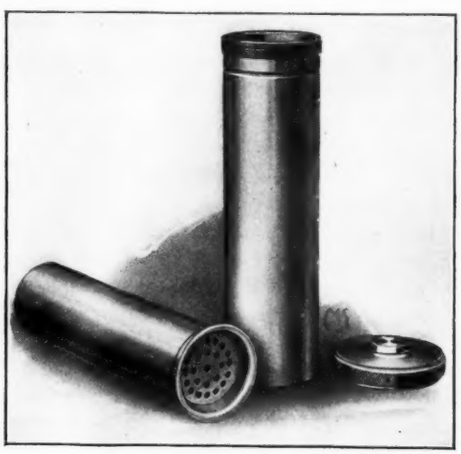


FIG. 2. THE CARTRIDGE

treated pumice which absorbs the ammonia from the air. This charge of pumice will last over half an hour in an atmosphere strong with ammonia. The pumice is not

weakened when exposed to an atmosphere free from ammonia. Fig. 3 shows the helmet in its case.

The makers will furnish free for two years all the cartridges that may be required. The face cushion also will

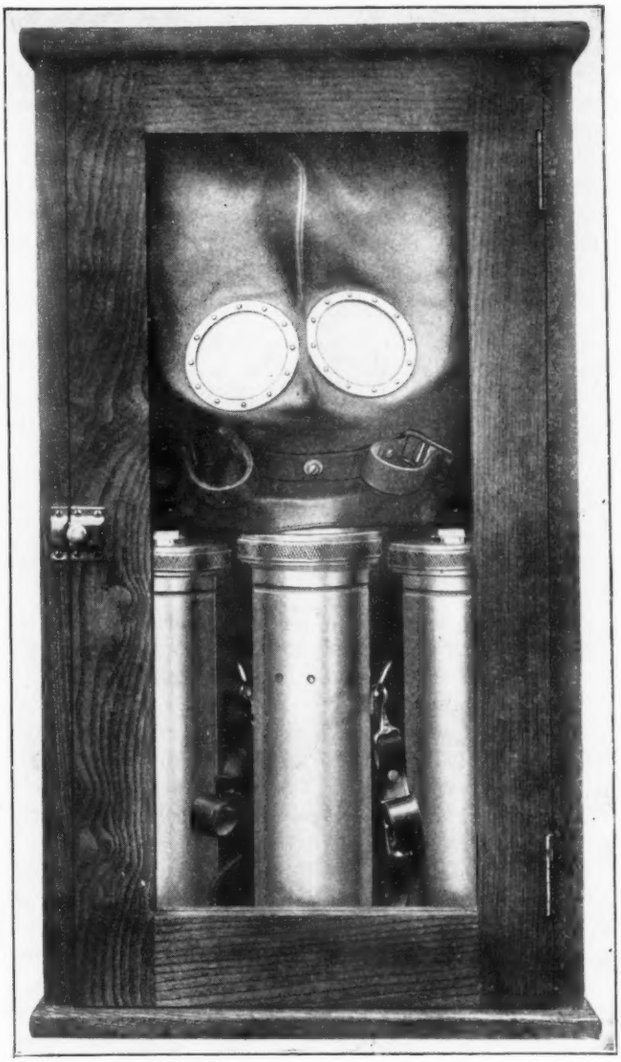


FIG. 3. HELMET IN ITS WALL CASE

be renewed once a year and oftener if necessary. After two years this service will cost $3 a year. The cost of the helmet with glass front case is $50; two in a double case for $95.

Transformer Regulation

By E. C. Parham

By the regulation of a transformer is meant the percentage or amount by which the secondary voltage increases when the full secondary load is removed. Thus, if the secondary voltage increases from 100 volts at full load to 102 volts at no load, the regulation is (102 — 100) ÷ 100 = 2 per cent. The regulation depends on both the resistance and the reactance of the transformer, and the reactance depends very much on the manner of grouping the primary and the secondary coils to the end of controlling the amount of magnetic leakage between them. If the interspacing of the primary and secondary coils is such that a comparatively large number of secondary lines of force fail to neutralize a corresponding number of primary lines of force, the counter-e.m.f. of the primary always will be comparatively high. Therefore the primary current, even with the secondary short-circuited, will be within reasonable limits.

Before systems with enormous generator power behind them became so common, transformers were designed with very low reactance so that their regulation would be as nearly perfect as possible. On modern high-power systems and in the case of very large transformers, this would mean almost an unmeasurable short-circuit current. With the advent of the heavy-energy systems, it has become the practice to design transformers with comparatively high reactance so as to limit the short-circuit current to a value that is unable to distort the transformer windings. Where the transformers are not of sufficiently high reactance to limit the short-circuit current to a reasonable value, it is customary to connect in series with them, external reactances.

Within the limits of safety, as suggested by the preceding, the reactance of a transformer of approved design is comparatively immaterial if it is to be operated alone. If it is to be paralleled with other transformers, the matter of internal reactance is important, because even though transformers are of the same rating, if their internal characteristics are different, they will be unable to divide the total load proportionately unless external reactances are used for equalizing the impedances.

So many instances of trouble have been due to trying to parallel transformers of similar ratings but of different impedances—hence of different regulations—that it is here purposed to suggest the advisability of measuring the regulations and thereby predetermining whether or not two or more transformers are qualified to operate in parallel. If two transformers are of different regulations, they will not parallel satisfactorily; and it follows that if two transformers fail to parallel satisfactorily, it is not out of order to measure their regulations. This is simply a matter of putting on full load, measuring the secondary voltage, then throwing off the load and again measuring the secondary voltage. If the regulations are different, the transformer having the better regulation should have connected in series with it sufficient reactance to make its regulation and reactance equal the regulation of the other. The additional external reactance will be a source of no more energy loss than if the additional reactance were included within the transformer itself. Where one transformer is already installed in an inaccessible location and it is desired to install another to be operated in parallel with it, much time, labor and annoyance may be saved by first measuring the regulations of each in order to determine whether parallel operation will be satisfactory.

Engine Foundations resting on soil, gravel or loose rock are likely to give trouble in preserving the engine-shaft alignment unless the bed and outboard bearing of the engine are supported on a monolithic foundation. For that purpose concrete foundation beds are usually made L-shaped, having the main foundation bed extended under the flywheel pit and the necessary distance beyond it for receiving the pier for the outboard bearing.

Cracks or Flaws in a smooth metallic surface are rendered visible by thoroughly moistening the surface with kerosene and then rubbing and drying it with a clean cloth and subsequently rubbing over the surface with chalk. The location of flaws will then be revealed by traces of the kerosene coming out again from the cracks into the chalk surfacing.

The Care of Leather Belting*

SYNOPSIS—The final low cost and dependability in service of leather belting cannot be obtained except through intelligent installation and careful upkeep. Factors that enter into this part of belting practice are: Regular inspections, cleaning and dressing, maintaining proper tensions, using suitable lacings and fastenings and reclaiming used belting.

When leather belting of good quality has been secured from a reliable source and careful inspection has shown its worth, two important steps have been taken toward low ultimate cost and dependability of service; but unless proper care is exercised in its installation and upkeep, much of this advantage will be lost and the final result be far from satisfactory.

Longer Life—In normal times first-quality leather belting is worth about $1 a pound and at present about $1.50. At the latter price a 3-in. single belt 25 ft. long represents an investment of over $15; and a 6-in. double, over $60. In any shop the total investment is appreciable, and in some of the large ones it exceeds $250,000. A similar amount of property in any other form is usually well cared for, but in most plants the belting is apt to receive less attention than any other part of the equipment. Usual practice is to do nothing until trouble develops. Few factory executives appreciate that good belting running under favorable conditions will last many years. Under ordinary conditions belts do not wear out; they are destroyed by abuse and neglect. It is entirely feasible to double and triple the life of most belts by reasonable care in service.

Better Service—Another factor in satisfactory belt service which does not receive the attention its importance warrants is loss of power and production through excessive slip. Pulley friction may be reduced below the economical point, due to belt stretch or to loss of gripping power when the belt becomes dry, long before the belt slips perceptibly. During this period the machine slows down gradually and yet consumes more power than it should. Regular inspection will discover this tendency before it becomes serious, and the remedy is easily applied.

Proper Installation of Leather Belting

The chief enemies of leather belting under ordinary conditions are abrasion, mineral oil, heat and overloads. They should be eliminated as far as possible when the drive is installed and the conditions kept up to this standard afterward by frequent inspection. The reason for the very common neglect to take these precautions is that any one factor detrimental to long life and good service is in itself apparently a trifling matter. Only those accustomed to handling leather appreciate how easily it may be injured and how well it repays good care.

Very many belts are brought to an untimely end by being allowed to rub against belt shifters, hangers, posts and machine frames. The result is frayed edges from which cracks may start and ultimately destroy the belt. Even before this can happen, the heat generated by the friction may burn the leather or open up cemented joints. Even more frequently, perhaps, are belts permitted to overrun the pulleys on one side, setting up severe strains in the fibers where they pass over the edge. When this occurs, the pulleys are usually found out of line or not parallel. If the pulleys are correct, the belt is at fault and should be rejected. The use of pulleys 25 per cent. wider than the belt will lessen this evil considerably.

Mineral oil destroys leather much as it does rubber, but less rapidly. Every effort within reason should be made to prevent lubricating oil from reaching the belt; and where this is not feasible, frequent cleaning is necessary, as outlined later.

High Temperatures Detrimental

Oak-tanned leather becomes brittle and lifeless when subjected to a temperature of 200 deg. F. or even less. Where slip is not excessive and metal pulleys are used, the heat is conducted away fast enough to protect the belt, unless the surrounding atmosphere is very hot. Pulleys of wood or other nonconductors are more severe on the belt. Chrome and several other specially tanned leathers will stand 400 deg. F. and will give better results where slip cannot be eliminated, as on reversing planer drives.

A belt that shows signs of being overloaded, by stretching rapidly or slipping when under proper tension, should receive immediate attention. The best remedy is a higher belt speed, obtained by using larger pulleys at both ends. A velocity of 4,000 ft. per min. is not excessive, but above this point the belt has a shorter life. If the speed cannot be increased, a wider belt will be beneficial. Double belts should be used only where necessary, especially on vertical drives.

Regular Inspection—The best way to cure belt troubles is to prevent them. Each drive should be inspected as often as experience indicates is necessary to prevent injury to or failure of the belt. Inspection while running will determine whether the belt is rubbing against anything, whether it is running true on the pulleys or is slipping. Inspection while idle should cover dryness, oiliness, weakness at the lacing or cemented joints and too much or too little tension. All repairs should be made promptly outside working hours, so as not to interfere with production. Small defects rapidly become worse, and "a stitch in time" is nowhere more valuable than in the care of belting.

During manufacture about 8 per cent. of animal grease is worked into the leather to lubricate the fibers and promote pliability. On belting for general use, a second application is desirable before shipment, bringing the total grease content up to 12 or 15 per cent. This is not done by the manufacturer unless requested, but is advised by the makers and, as a rule, no extra charge is made. Such belting will hug the pulley well from the start, will remain pliable longer and is fairly well protected against moisture, oil, fumes and other destructive agents. This also means that it will be much less affected by humidity changes than undressed belting.

This grease, however, gradually works out and must be replaced. All belts need regreasing once in six months, and those exposed to heat, dust, oil or moisture should receive this treatment at more frequent intervals. All dirt should be wiped off with a cloth or cotton waste

*For fuller discussion see "American Machinist" of Aug. 24, 1916.

dampened with water. In some cases a thorough scraping may be necessary to remove a heavy coating. Oily belts may be degreased by washing with naphtha, gasoline or carbon tetrachloride. Those completely saturated should be removed from the pulleys and immersed in solvent for several hours or packed in sawdust over night

Dressing should be applied lightly to the grain side of single belts and to both sides of double belts. The application should be repeated if necessary to produce a soft mellow condition of the leather. Any more than this will cause slippage on the pulleys.

The best dressing is that used in the original currying, a mixture of acidless tallow and cod-liver oil in equal proportions. The oil is heated to 110 deg. F. and the tallow added slowly. Unless carefully mixed, curdling will take place. Application to the belt should be made while hot, and several hours allowed for good penetration. Small firms may purchase a reliable dressing from any reputable belt manufacturer. Many injurious dressings are being exploited by irresponsible concerns, and caution is necessary in choosing a dressing of unknown composition. Most of them show good results for a time; but if they contain injurious ingredients, the belt will be destroyed prematurely. All sticky dressings should be avoided. A belt that will not pull its load when properly greased is too small for the job or is running too slowly.

The best way to install a belt is to make it endless with a cemented joint, provided the inevitable stretch can readily be taken up with an idler, an adjustable countershaft or other means.

The market offers a wide choice of fastenings, both leather and metal. Many of them are excellent for certain purposes, but none are suitable for universal application. The well-known rawhide lace is rapidly yielding to stronger and more lasting leather competitors, such as the chrome and oil tannages, as well as to the numerous forms of metallic fastenings. Whatever lacing is determined by experiment to be best adapted for a particular kind of drive, it is important that more care be taken in its application than is usually the case. Nor should its replacement be deferred until failure occurs.

Reclamation of Old Belting—Many belts supposedly worn out are still useful if intelligently treated. All dirt should be scraped off, the grease dissolved out, frayed edges trimmed, joints repaired and new grease applied. Even if this treatment does not renew its usefulness for the drive on which it was originally installed, frequently such a belt will give satisfactory service under less severe conditions of service.

Ventilation of Battery Rooms

By M. A. Walker

SYNOPSIS—The rate at which hydrogen gas is given off by lead storage batteries when charging, the danger of explosions caused by this gas when mixed with the proper proportion of air and the various methods of effectively ventilating the battery room are described.

While much has been written about the storage battery as to its performance, its chemical action and reaction, its care, and its use for divers purposes, there appears to be scant information available concerning the building in which the battery is to be housed. One of the most important factors affected by the design of the building in which the battery is installed is that of ventilation. Ventilation, or rather lack of ventilation, not only reacts to the detriment of the apparatus installed in the battery room, but it also constitutes a danger to life and property, on account of the likelihood of explosions occurring.

The danger of explosions taking place in battery rooms may be a very real one if proper precautions are not taken; and even when all reasonable care is exercised, the danger is potentially present a large portion of the time. The present-day demand for better service has resulted in the storage battery being a most convenient means of overcoming many problems incident to an improved electric service. The battery may be installed far removed from attention for considerable periods without detriment to itself or to the service it supplies; it may be installed out on a line instead of requiring that the cross-section of that line be increased for a given voltage drop; it often permits a station to be shut down entirely during light loads while the battery carries the burden, consequently allowing the central station to be operated at a better load factor and higher efficiency during the portion of the time it is in service by carrying the load and charging the battery at the same time. The sum total is that the storage battery is finding increasing favor on the large systems and in the small isolated plants, whether serving one customer or many.

Not infrequently the building for containing the battery is rushed to completion and the battery is installed without due regard to ventilation. Then, when it is too late to do the job the most effectively for the minimum cost, ventilating problems begin to develop. Ventilation may be considered from three different viewpoints—to prevent damage to apparatus in the battery room, to prevent damage outside but in close proximity to the battery room, and to prevent the possibility of explosions occurring. Damage to the apparatus housed in the battery room will be due to the acid spray and gases given off by the battery. These gases and acid are virulent and will attack the wooden tanks and any other woodwork in the room, the copper and other metal work. Acid is hygroscopic; that is to say it will absorb moisture instead of permitting it to evaporate, which only serves to augment the deleterious effect of the acid. The remedy is ample ventilation.

Ventilation may be of two kinds, natural or artificial. Of the two, natural draft is the preferable wherever feasible, because it is obtained without the continuous outlay of money and energy, and the difficulties often present in dealing with the acid-laden fumes under conditions of forced ventilation do not enter. Natural draft is obtained by constructing the battery room with high ceilings, vents and windows judiciously arranged and placing the battery so that air can circulate around

and under it effectively, instead of vacillating or becoming stagnant. Where natural ventilation is employed, it is especially important to leave ample space between the battery and the walls and floor, not only for free circulation of air, but also to permit men to overhaul and clean the various cells without being cramped for space.

Natural ventilation is the least costly and is the simpler, hence should be adopted wherever possible. It needs a larger room than forced ventilation, hence where real estate is valuable and space must be economized, the latter is generally resorted to. Another reason often precluding natural draft is that the acid fumes and spray escaping from the battery room cause annoyance in close proximity to the battery installation. Forced ventilation must then be used.

Two Kinds of Artificial Ventilation

Forced or artificial ventilation is usually specified as being of the pressure or the exhaust system. The former draws the air into the battery room from the outside, whereas the exhaust system draws the air from the floor and other parts of the entire room and drives the vapors out through one opening. With the pressure system it is often necessary to employ air-washing or cleaning screens, especially in localities where the air is laden with dirt and foreign particles. It does not entirely clear the room of globules of acid, etc., and instead of all the air and gas being sent out through one opening, part of the acid-laden fumes pass into the crevices and interstices of the building, causing gradual but eventual deterioration. On the other hand, the exhaust system gives better results in every way. The gases are drawn out through one opening, the path of least resistance; the velocity is such that moisture and condensation has little opportunity to settle, and the circulation of air is more efficient; that is, there are less chances of air pockets and stagnant zones forming.

It sometimes happens that the battery room has to be built where there are serious space limitations and the battery is installed very close to the walls and floor. Under these circumstances it may be necessary to use a combination of pressure and exhaust ventilation lest local stagnant zones exist wherein trouble may occur from chemical attack.

The volume of air that should enter and leave the battery room in a unit of time is not so much that which will prevent the taking up of moisture by the acid, hence the disintegration of the fibrous, cuprous and ferric contents of the room, but that which will prevent the formation of an explosive mixture. If the circulation is sufficient to prevent this latter for the battery room of usual dimensions, it will be ample for the former.

When a storage battery is being charged, hydrogen gas is evolved. Hydrogen is given off by both plates, although that from the positive plate is so small compared to that from the negative that it is generally not taken into consideration. The volume of hydrogen gas given off for each fully charged cell is 0.01474 cu.ft. per ampere-hour of charge, irrespective of the rate of charging. Hydrogen gas when mixed with air in the proportion of 8 parts of hydrogen to 92 parts of air forms an explosive mixture. Since the evolution of the hydrogen is one of the chemical reactions, it cannot be prevented, and means must be found to hinder the formation of this explosive mixture from becoming a serious hazard. This is accomplished by proper ventilation, in that way not permitting the requisite mixture of hydrogen and air; and by not permitting naked flames to come within the possible danger zone.

Since the amount of gas generated by a given battery is easily determined, the time required for an explosive mixture to accumulate in a room of definite cubic content may be readily determined. Once this value is known, it remains to secure a ventilating system that will completely change the air in the room at least twice as rapidly as an explosive mixture can be formed. Under those conditions the factor of safety would be said to be two. It should never be less, and three is preferable, because it is always advisable to play safe and allow for air pockets.

For example, suppose that a battery of 130 cells is being charged at the normal rate of 1,200 amp. In one hour it will give off 2,299 cu.ft. of hydrogen. To constitute an explosive mixture this hydrogen would require air in the proportion of 92 parts to 8 parts of hydrogen, or about 26,440 cu.ft. for an explosive mixture to exist at the end of an hour with the battery gassing freely. Allowing a factor of two, the movement of air would have to be about 55,000 cu.ft. per hr. This volume of air would not be needed continuously, but only while the battery was gassing freely. Natural ventilation might suffice during the normal performance of the battery and forced ventilation could be resorted to when needed, or natural draft relied upon at all times. It is better to have a too rapid circulation of air than one that is too sluggish, but the happy medium should be aimed at. When the circulation is excessive, the electrolyte will evaporate more rapidly, which means more frequent attention in this respect. It is, however, advisable always to use covers for the cells, since they save considerable loss in acid during the gassing period and from evaporation.

End-Cell Switch in Separate Room

In the usual arrangement of cells a definite number of units are connected in series, the actual number depending upon the voltage of the circuit. In many cases a number of the cells are connected to an end-cell switch for voltage regulation. The end-cell switches should be installed in a separate room from that containing the battery, on account of the deterioration that would otherwise take place. There is another reason also, and that is to prevent the possibility of an arc or naked flame in the battery room caused by accidentally opening the circuit. All switches and other current-interrupting appliances should be installed outside the battery room proper, if for no other reason than on the grounds of safety.

It is not enough to ventilate the battery room so that the risk of explosion is reduced to a minimum, but further precautions should be rigidly insisted upon. Use only lamps that are protected from injury, so they cannot explode. Forbid the use of matches or cigarettes, cigars, etc., in the battery room. Use a heating torch only after it has been definitely ascertained that the room is free from hydrogen. Keep the battery room locked, and post notices on the doors stating the danger. Battery rooms do, potentially, constitute a hazard. The risk is slight, however, provided ample ventilation is maintained and proper precautions are observed.

Editorials

The Ford Steam-Gas Power Plant

The Ford plant, at Detroit, is one of the few large American industrial works operated by producer-gas engines. For a couple of years there have been rumors of a purpose on the part of the Ford engineers to couple up with these large gas-driven units steam engines, the deficiencies of which should make an opportunity for the useful application of some of the heat rejected by the internal-combustion machines. Speculation and curiosity with regard to these gas-steam units have been rife, and it is with particular pleasure that we are enabled, through the courtesy of W. B. Mayo, engineer of the Ford Motor Co., and the coöperation of E. A. Le Suer, his assistant, to present as the leading article of this issue a statement of what is being done and a description of the system sufficiently concrete to enable an engineer to judge of its merits and to discuss it intelligently. This article considers the plan in the abstract; a second article will deal with the engine room, describing in detail the composite engine units; a third will take up the producer plant and the boiler room, which contains the largest boiler units yet made anywhere[1]; and the fourth will describe the switchboard and electrical features of the installation.

As yet the plant is only partly installed, and any statement of its ultimate efficiency must be based upon speculation or an estimate of what is possible under given conditions. The gas engines and producers have been operating for some years, and their performance is fairly well established. The guaranteed steam rate of the steam-driven units—10.9 pounds per indicated horsepower-hour, with steam of 175 pounds (gage) pressure, 500 degrees Fahrenheit temperature and 26 inches vacuum—is not unreasonable, being about 1.38 times that theoretically required with adiabatic expansion. With the 600 degrees which it is intended to use, it is about 1.47 times the theoretical. Neither of these statements takes account of the effect of the gas-heated jackets or of the reheating between the cylinders. The temperature of the gas-engine exhaust, as it is voided to the chimneys, is expected to be approximately 300 degrees, and with liberal passages and the diminution in volume of the gas by cooling to about half of that with which it leaves the cylinders, it is expected that there will not be a very material increase of back pressure upon the engines. The assumption that 25 per cent. of the energy in the gas can be converted into brake-horsepower, with 28 per cent. to the jackets and 30 in the exhaust, leaves 17 per cent. for radiation and friction; allowing 3 per cent. for radiation would make the mechanical efficiency 86 per cent., and the conversion to indicated horsepower 29.1 per cent., which is reasonable.

Compared upon a power basis alone, if the boilers can be counted upon for an over-all efficiency of 75 per cent. and the engines, without the gas jacketing and reheating and with the natural variation of load, for a steam rate of 12 pounds per indicated horsepower-hour, there would be used, allowing nothing for the exhaust, 1.75 pounds of 12,000-B.t.u. coal per indicated horsepower-hour. With the same 75 per cent. efficiency for the producers and 30 per cent. of the heat in the gas converted into mechanical energy, there would be required a little over a pound of the same coal per indicated horsepower-hour. When the demand for steam for heating will use up all its exhaust, a noncondensing steam plant is pretty nearly a 100-per cent. proposition. The more nearly the conditions approach to a purely power demand, the more the use of a purely gas-engine installation will be indicated by a consideration only of the fuel consumption. The more nearly the conditions approach to utilizing the whole of the exhaust, the more a steam-engine plant would be indicated. The plant described is probably the result of an equation of these considerations, with the probable demand of the Ford works, modified by the stability and dependability afforded by the use of the ever-ready steam unit.

[1]Power, Oct. 3, 1916, p. 474.

Electrical Power-House and Transmission Equipment

When the equipment for the generation and transmission of energy by electricity is referred to, it usually carries with it a mental picture of boilers, engines or water-wheels, generators, switchboards, instruments and transmission lines, etc. This equipment performs the primary part of producing and transmitting energy, but there is a vast number of other devices, originally intended for some other purpose, that today form a very important part in the generation and transmission of electrical energy.

The oldest of these is probably the relay. As first developed, it was used to increase the distance that a telegraph message might be sent, but it has now become one of the most important parts of the control equipment in the power plant. This is apparent by the vast variety of types, among which are the instantaneous overload, inverse time-limit, inverse definite time-limit, balanced selective relays, etc. Relays are constructed to operate under almost innumerable conditions in the vast network of power houses, substations and transmission lines of a modern power system.

The automobile, which is generally looked upon as filling a purpose far removed from the supply of light and power for our industrial and economic needs, is today performing a very important part in this vastest of industries. Many of the large power companies employ hundreds of these machines for many purposes, from transferring the workmen and material from one job to another to performing certain parts of the construction work. One of the most important uses is for the quick dispatch of men along a transmission line in case of trouble.

The locomotive also serves its part, although usually of the electric type, and has come into extensive use about large power plants.

The telautograph was originally designed to operate in conjunction with a telegraph system and has been used to quite an extent for various signal purposes, but has

also found a place of utility in the power plant and is used in many cases to signal between the operators on the high- and low-tension switchboards, or the operator and the engineer, and for various other purposes.

Among the many important rôles played by the telephone in the generation and transmission of energy by electricity is that of transmitting information as to the condition at different points on a long transmission line. No transmission line today is considered complete unless it is paralleled by the company's own telephone line.

The latest addition to the devices is the wireless telegraph. One of the large Western power companies has recently installed a wireless station to be used as an auxiliary means of communication when the telephone line that follows the transmission system fails. This new adjunct is expected to perform a valuable service when the telephone lines are down, especially in case of storms. Although this is probably the first application of wireless as a means of communication in power-transmission systems, the aërial and coherer has been used as a storm detector with very satisfactory results, giving indications of approaching storms several hours in advance. These are only beginnings, but with the ever-increasing size of the transmission networks and the demands for a continuous and adequate electric service, becoming more urgent, wireless telegraphy may be looked to as a reliable means of communication from one point on the system to another when other means fail.

Advance in Thrust-Bearing Design

It is quite human, in an age of notable advances in prime-mover design, in capacities of single units, in power-house construction, in pressures and superheat and in other big things, to overlook or inadequately appreciate improvements, some of which are remarkable, in the design of some of the minor parts of plant apparatus. Among these is the thrust bearing.

To most of us a thrust bearing means a shaft having a number of collars set close together and revolving in grooves in the bearing housing. A little study into the fruits of lubrication-research work will reveal to the uninitiated that the proper lubrication of the collar type of thrust bearing is so difficult as to prohibit the carrying of heavy loads upon such a bearing without extremely high power consumption.

Beauchamp Tower long ago observed that with well-lubricated high-speed bearings the journal never or, to be conservative, at least seldom makes metallic contact with the brasses or bearing metal. Experience has shown that high-speed bearings after many years of more or less continuous service have little or no wear. Why this is so, why the journal does not touch the bearing after getting up to its normally high speed, was so well explained by Osborne Reynolds long ago, in the "Philosophical Transactions" (1866) that we urge every engineer who has not read the explanation to visit the public or engineering library in his town or the nearest city and spend the profitable two hours that such reading offers.

Briefly, Reynolds' explanation is as follows: Where the bearing is well lubricated, the journal is not concentric with its bearing when running and, owing to the revolving action of the journal, the oil is dragged into the wedge-like space between journal and bearing, is literally pumped in, the film of oil so drawn in attaining a very high pressure depending, of course, upon the weight supported, thus holding the journal away from the bearing. The greater the speed the more oil is dragged in and the higher the journal is raised off the bearing. Readers will likely remember that in describing the lubrication of the bearings of a thousand-ton ammonia compressor, F. L. Fairbanks told in *Power* for December seventh of last year, how the dial micrometer was used to measure the rise and fall of the shaft for different speeds and different oils. Several such demonstrations of the correctness of Reynolds' explanation have been given by others; Stribeck and Lasche, for example.

One soon perceives that such action with the common collar-type thrust bearing is impossible. There is no chance for a wedge of oil to get between the collars and the grooves, consequently the higher the speed or the greater the thrust, the more sure is the contact between the metal collars and their supporting grooves and the greater the power loss due to friction.

The design of a thrust bearing to utilize the inherent advantages of the revolving cylindrical journal was therefore a progressive step, seemingly not as widely appreciated, especially by operators, as its importance warrants, considering that such thrust bearings have been in use for the last few years.

The first bearing of this kind to receive application was that invented by Albert Kingsbury, of Pittsburgh. There soon followed that invented by A. G. M. Michell, of Melbourne. Mr. Kingsbury's bearings have already been described (*Power*, May 13, 1913) and Michell's will appear soon in *Power*. In each bearing the means of obtaining the advantages of the load-bearing oil film are, after all, simple. The stationary load-supporting surface is divided into a number of sectors which are spherical on the lubricated side or which have spherical inserts pivoted so as to tip according to the direction of motion of the shaft. At each sector or insert the oil assumes the wedge shape, and the lubricating and supporting effect is the same as had in the ordinary journal.

Somehow this achievement—worthy indeed of commendation—seems to have been ushered in at a time when the trumpet blasts of bigger things monopolized attention.

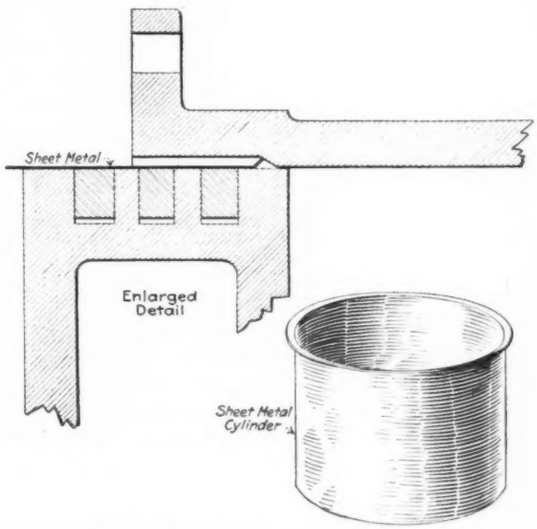
It is indeed gratifying to note the amicable adjustment of the maximum electric rates in New York City, whereby the New York Edison Company has offered a reduction to seven and a half cents and at the expiration of six months to seven cents per kilowatt-hour in lieu of an appraisal and further action by the Public Service Commission. While the personnel of the present commission undoubtedly had much to do with this decision of the company, still the latter is to be congratulated on its good judgment in anticipating the inevitable and thus saving the expense and delay incident to an appraisal.

The Louisiana State Legislature has made a start toward the adoption of the American Society of Mechanical Engineers' Boiler Code, by authorizing the governor to appoint a committee of five experts to examine the Code and report to the Assembly whether, in their judgment, it should be adopted. Since the personnel of the committee will no doubt be of the highest, there is little doubt as to their finding in the case.

Correspondence

Putting Piston Into Cylinder

Inserting a piston into a cylinder is a task that may be lightened by the use of a thin sheet-iron or tin cylinder, as shown in the illustration. The tin tube is of the same diameter as the piston, and a flared edge at one end makes it easy to slip it over the piston rings. When



PISTON BEING INSERTED INTO THE CYLINDER

moving the piston into the cylinder, this edge of the tube will be caught on the edge of the counterbore of the cylinder and the piston goes on, provided the distance between the end of the tube and the cylinder is less than the width of the rings. The tube may be used for the safe storage of spare rings. JAN SPAANDER.

Brooklyn, N. Y.

Central-Station Methods in Private Power Plants

In the issue of May 16, page 693, J. A. McHollan discussed a very important point, the supervision company idea for isolated power plants, and this idea was favorably commented upon editorially. Perhaps a further discussion of the matter would be of benefit to private-plant owners. This idea has been pretty thoroughly worked out in New York City, where one company has been in existence for nearly twenty years. The city, realizing the necessity for plant supervision, has an official paid $3,600 per annum, called the supervising engineer for power plants. Many large manufacturing companies having more than one plant have a supervisory engineer, so that they may be sure not only of uniformity of operation, but also of lowest operating cost; large real-estate companies controlling so many of the important buildings employ supervisory engineers; and central stations have always realized the necessity for careful supervision, and they spend large sums in maintaining special departments for supervising every detail of power-plant operation.

Concentration of population and business in trade centers, together with modern equipment in skyscraper buildings, has saddled the real-estate owner with burdens he is not well qualified to bear. Buying, selling and renting are in the realms of business, but the department of plant and building management is strictly engineering and should be taken care of by a staff of trained engineers or a supervision company whose duty it would be to coöperate with the chief engineer in running tests and discovering waste, etc. The plant would then receive the benefit of the knowledge and experience gained in operating plants of all types for many years, and by taking care of repairs when they are first needed, trouble would be avoided and repair bills kept at a minimum.

Sometimes additional apparatus will pay for itself in a short time. For instance, in one plant a high-efficiency engine-generator unit large enough to take the load of several slide-valve engines demonstrated its usefulness in giving much-needed additional capacity and reducing the coal bill alone about $2,000 a year. The cost of installing this unit was unusually low, because the supervising company designed and laid out the work so that the regular crew could do most of it. Such service is a means of relieving the owner from the responsibility for the plant operation, and it stands in an intermediate position between the central and the isloated plant and has some advantages over each. RAYMOND W. BRISTOL.

New York City.

Favors the Atmospheric Exhaust Pipe

I would like to inquire of the designing engineers of the Fremont, Ohio, power plant, a description of which appeared on page 576 of the Oct. 24 issue, as to what advantages are claimed through dispensing with the atmospheric exhaust connection on the turbines.

It seems to me, from an operating standpoint, that it would be better to have an atmospheric relief valve connected to the turbine exhaust and then, in case trouble was experienced with the vacuum, the machine would not lose its load entirely, and that would give the operating engineer a chance to reëstablish the vacuum if possible. In the event that the machine was running alone on the line, it might save a temporary shutdown if the load was not too heavy.

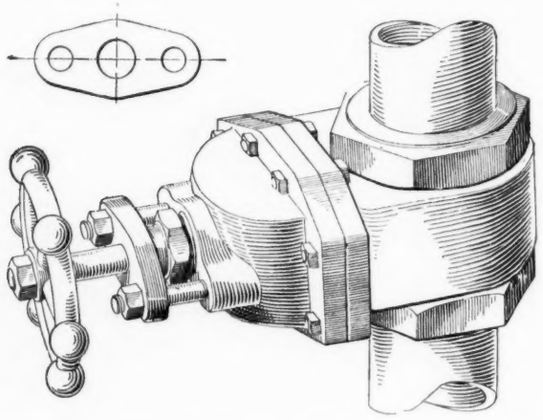
In my operating experience I have lost the vacuum several times on turbines running alone and by quickly relieving the machine of some of the heavy load I have kept it running and have reëstablished the vacuum without any serious interruption of the service.

Let us hear from the designer and also from the boys who have to keep the "juice on" after the designer is through with the plant. What is their opinion of this idea? O. J. RICHMOND.

Danbury Conn.

Correct Position for Gland

I take great interest in the "kinks" sent in by *Power* readers and am sending one of my own ideas—to promote easy operation of the stuffing-box gland nuts on ordinary gate and globe valves. The bonnet should be placed on the valve in such a manner as to bring the gland studs in



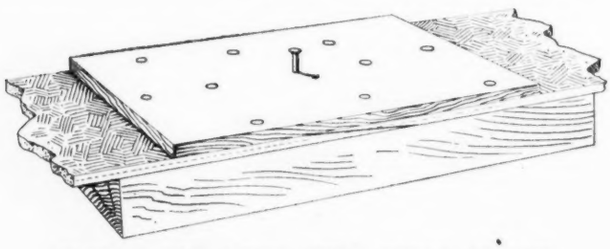
STUFFING-BOX LEAKAGE SHOULD CLEAR STUDS

a horizontal position, so that any drip from the stuffing-box will not fall on the nuts. These will then always be found free, and adjustment will be easy and safe. No matter how well packed the valves are, there is usually a little drip that will stick the lower nut if the gland is placed in a vertical position. L. R. HOFFMAN.

Oil City, Penn.

Repairing or Splicing Belts

A number of articles have appeared from time to time in *Power* on the subject of splicing belts, but I have made use of one kink that I have not seen mentioned and that may be of interest. It consists in simply placing a thick board under the joint and a thin one over it and nailing the two together, driving slender wire nails right through the belt and putting in enough of them to make sure that all parts of the joint are pressed



GLUED BELT BEING HELD WHILE DRYING

firmly together. If half-inch boards are used on top, sixpenny nails are large enough. The holes made do not injure the belt, and they disappear almost entirely after it has been in use a short time.

A large belt was in very bad condition, and a number of splices were made as described. Later a machinist was employed to overhaul the engine, and as some joints in the belt had opened slightly, he decided to give them an overhauling also. The splices that I had made were found sound and good. The machinist prepared the joints in the usual way, and for a means of clamping he laid the belt on a straight, smooth plank, laid boards on top and piled on a lot of iron for weight. He said that my way as described might do as a makeshift, but that his was much better. However, when the belt was put in service, although the joints had been well prepared and the glue was good, loose places again appeared along the edges where not held together well enough.

Green River, Wyo. G. E. MILES.

Air Pressure Required for Air Lift

In the issue of Oct. 10, page 535, under "Inquiries of General Interest," a correspondent requested information as to the air pressure necessary to pump water from 25 ft. below the surface to 50 ft. above ground. The reply is correct in so far as the direct question is concerned, but from a strictly engineering standpoint it would be extremely unwise to handle the entire lift with compressed air, owing to the inefficiency of air-lift apparatus. A better plan would be to raise the water by the air lift as far as the surface of the ground and then put it up the remaining 50 ft. with either a centrifugal or a reciprocating pump, depending on power conditions. This is the customary method throughout the West, and it is much cheaper than by air, as can be seen by comparing the power necessary to compress air to various pressures with that used to operate a service pump. In the problem given it will take at least 48.7 lb. air pressure at the well, and to compress one cubic foot of free air to 48.7 lb., single compression, requires approximately 0.134 hp. with the usual 15 per cent. allowance for friction. The pressure to simply raise the water to the ground surface would be 16.2 lb., and the horsepower per cubic foot of air would be 0.057. There will also be quite a little economy in the amount of air required. Based on Rix's formula, the volume of air per gallon of water is as follows:

$$Va = 0.8\left(\frac{h}{C \log \frac{H+34}{34}}\right)$$

in which

Va = Free air (actual) required to raise one gallon of water;
h = Total lift in feet;
H = Running submergence in feet;
C = Constant of 245 for this lift.

The constant in this formula varies according to the total height, and 245 is given for any lift up to 60 ft. For lifts from 60 to 200 ft. the constant drops to 233, but in calculating a comparison of the air required in the given instance, the first-named figure would be nearer for both cases. The inefficiency of air lift is due partly to compressor and pipe-line losses and partly to slippage of air past the water as it is raised in the well.

Where wells are deep and the distance above the surface of the ground to be pumped is not great in proportion to the total lift, it is possible to install what is known as a "booster," which is a tank utilizing the pressure in the air as it reaches the ground level, and without additional apparatus forces the water to the desired height. But this is not applicable where the distance above the ground is greater than 25 per cent. of the total height and is therefore eliminated from the well under consideration.

Air lifts are interesting to figure, but it is at all times necessary to remember their inefficiency.

Philadelphia, Penn. THOMAS F. CRAWFORD.

[The answer referred to was confined to the specific question. Conditions in any case should govern, for the losses in the air lift, even for elevations large in proportion to the submergence, etc., may be less than those incidental to the maintenance of a separate pumping unit, perhaps at considerable distance, attendance and other conditions considered.—Editor.]

Feeding Return-Tubular Boiler*

I know of one return-tubular boiler that was fed through the blowoff pipe, and sediment piled up over the bridge-wall until the sheet bulged. After having it repaired, the engineer changed the feed pipe to the front end, below the tubes. I operated this boiler for three years with the feed entering at this point and know that there was no trouble from blistering or with sediment collecting around or near the feed pipe.

I have experimented, trying out all sorts of devices and places for introducing the feed water, but find nothing better than the straight pipe entering the front head below the tubes and delivering the water about 3 ft. from the front end toward the rear. This drives all sediment and scale to the blowoff pipe at the rear, and regular blowing down takes care of the loose scale. The short section of pipe in the smoke box that is exposed to the hot gases should be renewed about once a year. This is neither very troublesome nor expensive upkeep for a year for a feed line if it will obviate other more serious trouble, as it seems to do. A. A. BLANCHARD.

Ringwood Manor, N. J.

Experience With Ammonia Leaks

While I was visiting the plant of a friend, he informed me that he had considerable trouble with the aqua pump. It had been in operation but two months when the nipple

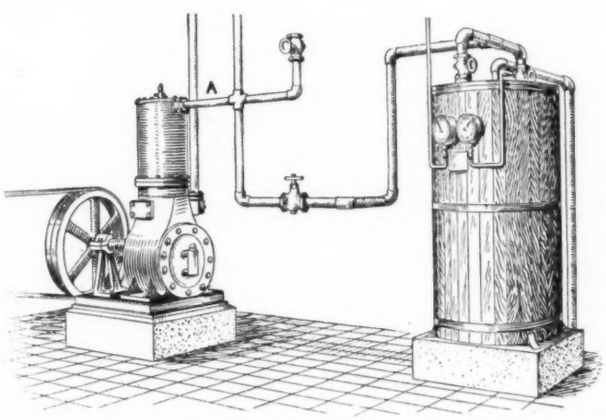


FIG. 1. SHOWING LOCATION OF LEAK

A, Fig. 1, began to leak. A new one was put in. It, too, soon leaked and was replaced with one of double extra-heavy dimensions. Unfortunately, the aqua pump developed a crack soon after the insertion of the extra-heavy nipple. Attempts to patch the pump failed.

*See also "What Bags the Boiler?" "Power," Aug. 1, p. 173; Sept. 12, 19 and 26, pp. 392, 428 and 461; Oct. 17 and 24, pp. 566 and 597.

Convinced that the crack was not due to shrinkage strains in the pump, but to strain imposed because of the character of the piping, I changed this piping from the arrangement in Fig. 1 to that shown in Fig. 2. The pump installed after the change in piping has not developed a crack.

I was sent for in a hurry one night, and upon my arrival the engineer informed me that the accumulator coil had burst and that he had told the engineer to pump

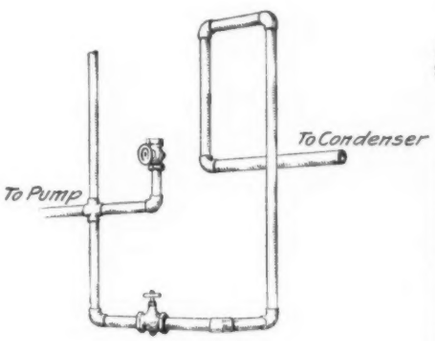


FIG. 2. PIPING IN FIG 1 REARRANGED TO AVOID LEAK PRODUCING STRAINS

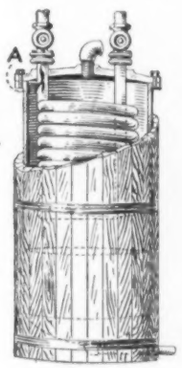


FIG. 3. THE COIL BURST AT A BECAUSE OF HIGH PRESSURE

back all of the ammonia that could be possibly pumped from the accumulator. To fill the storage-room coils and the high-pressure lines from the receiver valve to the regulating valves would have been the correct thing to do, if the coil had burst inside the accumulator. The gage on the board showed a condenser pressure of 125 lb. and a back pressure of 10 in. vacuum. The machine was running at a very high speed and working under excessive pressure, evidently. When I went to the accumulator room, the ammonia fumes were so strong as to drive me out. This convinced me that a gasket had blown and that, to eliminate the possibility of taking air into the system, the engineer should reduce the speed of the compressor and maintain a back pressure of 2 lb. While we were discussing the situation, a gasket on the high-pressure trap blew out, so that we had to shut down.

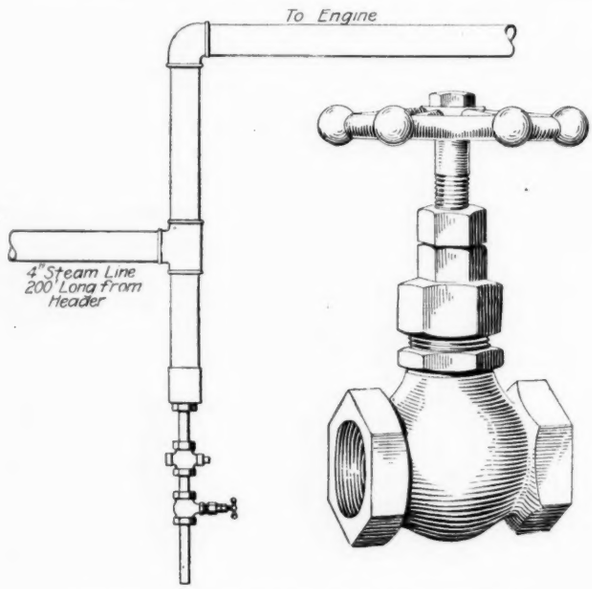
Suspicions as to the exceedingly high pressure were well founded, for it was discovered later that the gage hand had gone all the way around once and was on its way around again. I calculated the pressure to be about 475 lb. Further investigation with the aid of a helmet showed a leak at *A* in the accumulator, Fig. 3. The two holes in the head of the accumulator were plugged where the two ends of the coils came through. The liquid ammonia was passed outside of the accumulator, and the plant operated in this way until a new coil arrived.

Jacksonville, Fla. J. C. PERENO.

Direct-Indirect Radiation is a form of direct radiator placed in the room, with air connections to the outside for ventilation. These radiators are placed in a box space and the heating surface is more or less jacketed in, so that the outside air may be brought in contact with the surface of the radiator. Dampers are provided in order that the air connection to the outside may be shut off and the air of the room recirculated. This is only a makeshift as far as ventilation is concerned, as the air supply is uncertain and inadequate, and the jacketing of the radiator destroys its efficiency as a direct heating surface. In some cases the air current will be found to be from the room out of doors instead of inward.

Locknuts on Valve Stem

A 16x18-in. throttle-governed engine driving a ventilating fan and situated over 200 ft. from boiler house has the piping arrangement as shown in the illustration, for collecting and draining the condensate from the line



VALVE STEM LOCKED TO AVOID CLOSING

through a ½-in. plug-cock and globe valve in the bleeder. Someone shut the globe valve on the bleeder at a time when we were experiencing trouble with dirty feed water, resulting in a partly wrecked engine caused by water carrying over. To insure against further trouble of this kind we cut threads on the valve stem and put on a nut and locknut. The valve is now opened the desired amount, and the nuts are screwed against the packing nut and locked tight so that the valve cannot be closed without slacking the nuts. JACK L. BALL.

Amsterdam, Ohio.

Excessive Blowback of Safety Valve

We were carrying a peak load on six boilers under forced draft. Trouble developed with one of the big units, and it had to be stopped on such short notice that regulating the draft for controlling the rise of steam pressure was impossible, and we were obliged to let the safety valves blow until we had the fires controlled.

All the valves lifted nicely, and all except one seated promptly after the pressure had dropped; but No. 2 had one valve that stuck open, so I put a gag on and tightened it down. This brought it to seat and stopped the blowing. I found that the engine trouble would soon be over and this boiler would be needed in a few minutes, but the problem was, should we steam with that gag on one valve and depend on the other two of the set? For when I let up on the gag, it began blowing again, although the pressure was only 230 lb. This puzzled me, for it lifted the first time on the mark (265 lb.), showing that the setting was correct. I decided to see if the blowback ring could have anything to do with it, and this was a "happy thought," for therein was the fault.

The plug for securing this ring had got loose and unscrewed just enough to permit the adjusting ring to move by the vibration of the blowing and it had moved the wrong way; that is, toward the valve. This kept it open, and when the gag was pulled down, the ring made a seat in place of the valve disk itself.

When I found that the plug was loose, I tried to move the adjusting ring but could not. So, when the steam was up to 260 lb. again, I took the gag off and let the valve blow. Moving the ring this time was easy for the steam was lifting it, so I ran the ring up on the valve about one and a half turns and secured it, and the valve seated and lifted without any further trouble.

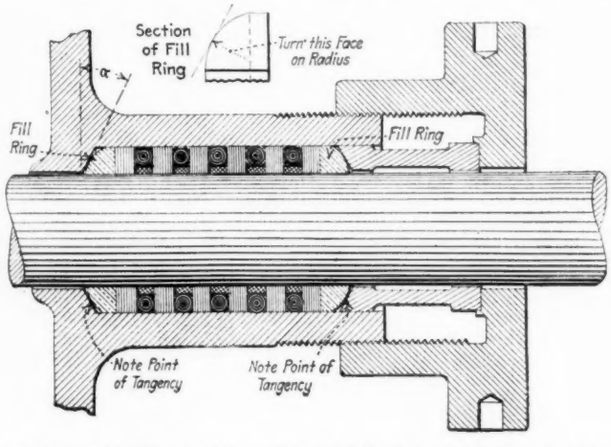
Concord, N. H. H. C. WILLIAMS.

Changes to Stuffing-Box of Ammonia Compressor

BY CARL JEFFERSON

Stuffing-boxes on the older types of ammonia compressors usually were bored with a beveled bottom, and the packing faces of the glands were also beveled, the aim being to wedge the packing against the rod. This type of stuffing-box on the reciprocating rod simply puts a greater tension on the outside diameter of the packing, while the rod surface of the packing is pulled either into the gland or the compressor. Machines of today are built with square-faced glands and square bottoms to the stuffing-boxes.

In case a metallic or semimetallic packing is to be inserted in one of these beveled boxes, it is necessary to



CAST-IRON FILL RINGS TO PREVENT PACKING BEING DRAWN IN OR OUT WITH THE ROD

first put in fill rings so that square faces are produced by which the packing may be tightened. A difficulty in making these fill rings is that the angle a as shown may be 15 or 30 deg., or whatever the designer may have seen fit, and as it is frequently difficult if not impossible to measure this angle, a standard fill ring to meet all these varying angles is desirable.

This is obtained by making one face of the fill ring rounded or on a radius. With this type of ring this rounded face will always find a point of tangency and will pull up square.

The Sight-Feed Glass of a Lubricator frequently fills with oil. If the oil is removed from the body of the cup and it is filled with water and started up in the usual way, the water will float the oil out of the glass without further trouble.

Far from Perpetual Motion

For a long time we had trouble from the choking up of drain lines from the kitchen sinks. After flushing the pipes out with water under pressure, they seemed to discharge freely enough, but in a short time they would be as bad as ever again. I also noticed that for a little while after the grease traps were opened for cleaning, the water would run much more freely. From this I got the idea that the traps became airbound. So I drilled the top of each trap and tapped it out for a ¼-in. air cock, which was left open all the time, and since then we have had no trouble.

The steam coil in one of our coffee water heaters would become water-logged and get cold, and the only relief was to open the bypass valve on the return-line trap in the boiler room, thus lowering the pressure on the return line and clearing the water out. This was found to be due to a low place in the return pipe under the heater. The pipe had been bent to pass under another pipe, and it trapped the condensation, which would gradually fill the coil. The trouble was easily remedied by straightening the pipe and putting it in so that it was lower where it entered the common return than where it left the coil. This emphasizes the need of great care in laying return lines from all apparatus, steam-heating systems and the like, in which the pressure on the return is equal to that on the steam side and gravity alone is depended on for drainage.

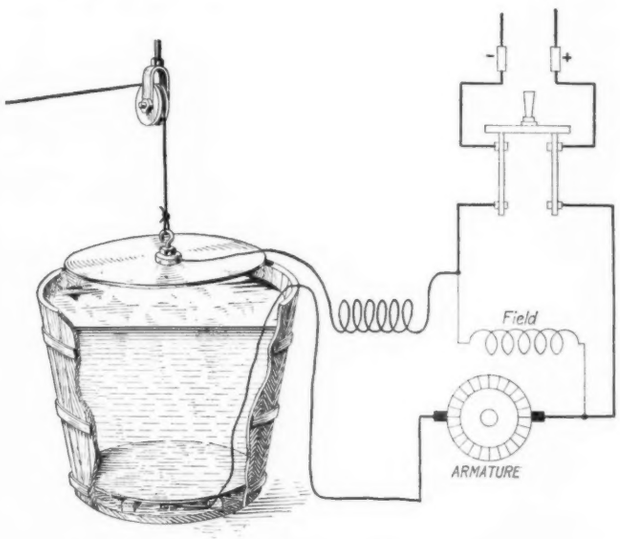


FIG. 1. WATER RHEOSTAT CONNECTED TO A SHUNT MOTOR

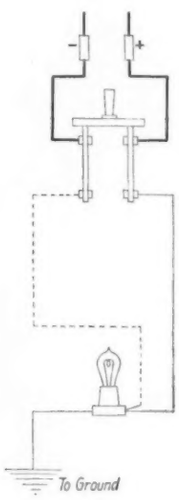


FIG. 2. TEST FOR GROUND

We had a number of radiators that gave the same trouble. It would have been very easy at the time of installation to get these pipes right, but after they were buried beneath concrete floors and the contractor had gone, the operating engineer had his own troubles for a while.

A hot-water pipe laid partly in the concrete roof would pull loose from the main and make a bad leak whenever the water in the system would get cold, because no provision had been made for expansion and contraction.

In the laundry, where 25 to 30 girls are employed using electric irons, I have constant trouble from blown fuses, burnt and ruined sockets and often burnt hands. So far I have been unable to overcome the difficulty. Can someone offer a helpful suggestion? W. G. CAMP.

Ash Fork, Ariz.

Temporary Starting Rheostats

The writer's experience with temporary rheostats has been along the lines of least resistance so to speak. Time was usually the essence of the situation; the available material was very limited, and results regardless of fine adjustments were desired. Many a direct-current motor has lain idle owing to the nonarrival of its starting box. It's a poor installation that cannot afford an empty lard tub, half-barrel or similar water-tight container, and two pieces of scrap boiler plate or flat cast iron. The tank should preferably be of some nonconductor; a wooden tub, a fiber washtub, an earthenware crock, an old churn—all these have served their turn. An iron tank can be used, but this would necessitate a lining of wooden strips or guides on the movable plate to prevent short-circuiting the resistance before the motor was up to speed. Fig. 1 gives an idea of the construction of the starter and the wiring connections. One plate is connected directly to an armature terminal and laid flat on the bottom of the tub. The other plate may be hung by a wire bale and a rope over a pulley or attached to a wooden handle. The wooden handle rigidly fastened to the plate is a little harder to make, but will work enough better, especially in small sizes, to more than compensate for the extra work. In any case the movable plate should be kept in a horizontal position and the leads attached to both plates so they will be flat together and make good contact in the running position. The lead to the lower plate should be cleated to the side of the tub and covered with a strip of board to prevent the movable plate swinging against it and short-circuiting the resistance. The tub should of course be filled with water and liberally salted.

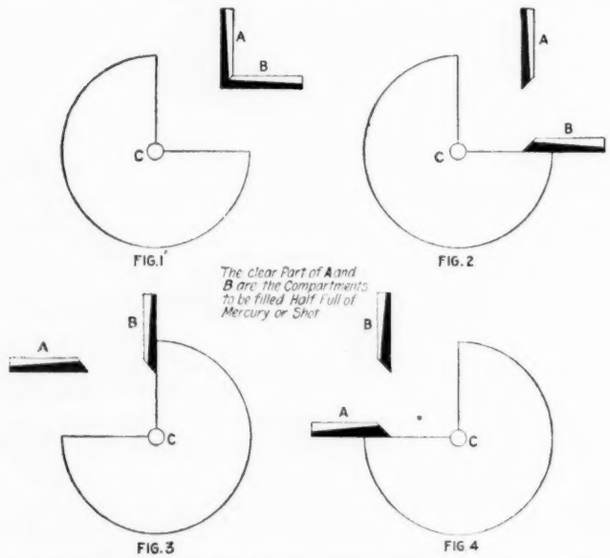
Before connecting the temporary starting rheostat, the power circuit should be tested carefully for grounds. This can be done as shown in Fig. 2, with a testing outfit which may consist of one 110-volt lamp on a 110-volt circuit, two 110-volt lamps in series on 220 volts and five on a 550-volt circuit. Connect one side of the testing device to ground as indicated in the figure (this may be a water main or gas pipe—anything metallic leading into the earth), then test first to one side and then to the other of the power switch as indicated by the full and dotted lines in the figure. The side that the lamp lights on is the ungrounded side of the line. If the line is grounded, the ungrounded side should be connected directly to one armature and field terminal of the motor. This is to reduce the personal hazard and obviate current leakage at the water rheostat. This arrangement is an emergency outfit and far from foolproof. Care must therefore be used to prevent accidents. A substantial barricade to keep unauthorized persons out of danger is a good investment. Several strips of wood should be cleated together to make a cover for the top of the tank. This can be slid in place under the upper plate when the motor is out of service. This scheme has been used on various voltages from 125 to 550 and on currents up to 200 amp. N. L. REA.

Schenectady, N. Y.

Far from Perpetual Motion

Detroit will soon be known not alone by the automobiles it produces or by the fact that more ships pass through the Detroit River than enter any of the large ports of the world, but because it will be the home of a power-producing perpetual-motion machine.

Many people are to sing the praises of one Richard Ulram, the inventor, who is not turning his invention over to the great capitalists, but is selling contracts for $10 to be exchanged for $1,000 worth of stock as soon as the company is incorporated. Nor is he to be done out of the vast wealth which is inevitably his who produces a power-producing perpetual-motion machine, for there is in each and every contract a clause which gives Mr. Ulram the



MOST COMPLETE WORKING DRAWINGS OBTAINABLE

right to buy in any or all of the stock at par within three years after the erection of the perpetual-motion machine. But will he use this mighty weapon to do away with the small stockholder? Never! He will need managers all over the world to manage the power-producing plants. Would he throw out the men who had faith in him to take on those who laugh at him now? No! There is something in his heart which wouldn't let him. The weapon is to be used only on any crank who might steal into the fold.

To be sure, there are no machines nor is there a model at present, but there are the blueprints on the wall, from which one may be made; and several diagrams explaining the principle upon which the machine will operate are lying about where those interested may use them to follow the explanation.

Now the secret of perptual motion is this. Others have failed because they have tried to lift one weight with another. "This could never be. What we must do is counteract gravity." And this is to be done as follows: Fig. 1 shows the end view of the principal mechanism. *C* is three-fourths of a cylindrical weight. *A* and *B* are individual weights of such equal mass as to balance the cylinder. Now the weight *B* is dropped to the position shown in Fig. 2, pulling a rack on a gear from which the power is transmitted by means of a shaft to a flywheel. The cylinder is still in balance, as we have not moved the weight out of its position relative to the center of mass.

If the cylinder is in balance, it will take very little power to turn it on its axis at the start. Of course, as it turns toward the position shown in Fig. 3, the cylinder will be out of balance, but never more than that of the weight itself. Therefore, taking the average of 0 to the weight, we would require only 50 per cent. of the power generated in the fall to turn the cylinder over a quarter turn. To aid in overcoming this lift, the weights are to be filled half full of shot or mercury, which will run toward the center, bringing the machine into a more perfect balance. When the cylinder arrives in the position shown in Fig. 3, the weight *A* is dropped, pulling *B* into the position shown in Fig. 4. The cylinder is then turned (oscillated) back to the position shown in Fig. 1, to go over the cycle again.

The power not required to turn the cylinder over will be transmitted through the flywheel to a dynamo and used to turn the wheels of the universe.

The inventor is sure he is right because no one has disproved, to him, his theory. To be sure he won't listen to a man who will not "admit facts." Furthermore, if he wasn't right, wouldn't someone take the $1,000 he offers to anyone who can prove to him that he cannot make a perpetual-motion machine? Professors have been there and couldn't dispute it.

When $10,000 is raised, he will build the machine and it will be demonstrated in all the large cities. Later, large units will be erected to generate power.

He is foxy enough to avoid conflict with the post-office authorities, for his advertisement in the Detroit *News* reads, "Please do not ask for demonstration by mail."

Detroit, Mich. F. H. Low.

[On page 553 in the issue of Oct. 17 is a copy of the advertisement carried in several daily and Sunday papers.—Editor.]

Solderless Copper-Wire Splice

Small jobs of line extension or repair work are expensive and difficult, and it is often impossible, at the time, to solder the joints. If the wires are carefully scraped and the joint made a good length and tightly twisted, then wrapped with tinfoil before being taped, the result is almost as good as if soldered. In fact, such joints are better than carelessly made soldered joints.

If heat is not applied to a joint until the solder is thoroughly worked into all the crevices between the wires, the flux will remain and cause corrosion and render the joint worse than if no attempt had been made to solder it. A good wrapping of tinfoil excludes moisture, and the wires will remain bright, so that a copper-to-copper joint will be secured. G. E. Miles.

Green River, Wyo.

Information Desired of Backrich Oil Engine—A correspondent has written in asking whether the Backrich (Austrian) semi-Diesel two-stroke-cycle oil engine was introduced into this country prior to the war, and if so the names of the parties that handled the engine; also whether an engine of that make is actually running in the United States. Perhaps some reader can furnish the desired information.

Drop Feed Oiling without means of collecting the oil after going once through is wasteful, although otherwise satisfactory as long as the flow is not interrupted.

An Occasional Squirt of Oil on a bearing is the worst form of lubrication—a feast-and-famine process, wasteful and insufficient, therefore inefficient.

Inquiries of General Interest

Eccentrically Bored Piston Rings—What is the object of having the bore of engine piston rings eccentric with their outside diameter? D. L.

Piston packing rings are bored eccentric to leave the greatest thickness at the middle of their length so as to obtain more uniform pressure against the walls of the cylinder.

Distinction Between Foaming and Priming—What is the difference between the terms "foaming" and "priming" of a boiler? P. N.

When the steam space contains unbroken bubbles of steam as from use of dirty feed water, the boiler is said to foam; and to prime if water is carried by the steam from the boiler, as from overloading or carrying the water level too high.

Frictionnl Resistance of Riveted Joints—In designing riveted joints for boilers, what allowance is made for friction between the plates due to the force with which the plates are drawn together by the rivets in cooling? G. S.

Although the holding power of riveted joints is enhanced by friction between the plates, its value is not relied upon among American engineers as a basis for calculation, because it is known that joints slip a little while in use before the working load of the joint is reached.

Fit of Corliss Valves—What clearance should be allowed between a steam valve and its seat on a Corliss engine of about 100 hp. working with a steam pressure of about 100 lb? A. A. B.

In operation Corliss engine valves are supposed to ride on their seats. To secure the proper fit it is customary to turn off the valve and end bearings to the size of an easy "driving fit," with the cylindrical end bearings dressed off only enough for freedom of motion, leaving the valve to become worn to the form of the seat. In order that a new valve may become thoroughly seated as soon as possible under the working conditions of pressure and temperature, it is customary to ease off the bearing spots shown by wear by scraping the face of the valve.

Kinetic Energy of Body Projected in Atmosphere—If a bullet is projected from a gun vertically into the atmosphere to a height of 2 miles, will it have the same power of penetration after falling from that height as when it was discharged from the gun? G. G.

If the bullet were both projected upward and fell in a vacuum, it would have the same kinetic energy at the end of its fall as it had in the beginning of its flight and would have the same penetration. But when it is projected upward and falls in the atmosphere, part of the energy is dissipated in overcoming the resistance of the air both in the upward flight and in the fall. Hence when the bullet has fallen to the starting point, it would have less kinetic energy and the power of penetration would be less than when it left the gun.

To Improve Gravity-Return Heating Apparatus—In a low-pressure gravity-return steam-heating apparatus the radiators become filled with water and the system will not return the water to the boiler when the boiler pressure is raised above 4 to 5 lb. What is the cause and the remedy for the trouble? T. M.

The water is not returned to the boiler because the pressure in the radiators, aided by the hydraulic head in the return pipes, is not sufficient to overcome the friction of flow in the return pipes and pressure in the boiler. The remedy would be either to increase the pressure of steam delivered to the radiators, by covering and increasing the size of the steam-supply pipes, branches and connections, or to increase the hydraulic head of the return pipes, by raising the level of the radiators and steam pipes or lowering the boiler.

Caustic Soda May Encourage Pitting—After two years' use a 36 in. by 10 ft. return-tubular boiler of a heating plant shows pitting of the tubes and shell. The water has not been changed except to replenish the usual losses of a gravity-return apparatus, and about 10 lb. of caustic soda has been added during each heating season. Is the use of the caustic soda of benefit in the prevention of pitting? W. A. A.

The presence of caustic soda may induce pitting by preventing a deposit of scale that would be beneficial in retarding corrosion. Carbonate and sulphate of lime, the ordinary ingredients of boiler scale, have little or no direct corrosive action unless the scale becomes too thick and causes overheating. The boiler should be blown off, thoroughly washed and refilled with the best feed water obtainable. If the water contains a corrosive acid, which will be shown if it turns blue litmus paper red, it will be advantageous to add only enough caustic soda to neutralize the acid. A thin coating of scale will not seriously detract from coal economy and in every probability will act as a protection against pitting.

Relative Economy of Evaporation—What is the relative economy of evaporation of 8 lb. of water per pound of coal from a feed-water temperature of 98 deg. F. into steam at 90 lb. boiler pressure and in the evaporation of 8½ lb. of water per pound of coal from a feed-water temperature of 180 deg. F. into steam at 180 lb. boiler pressure? F. L. M.

A pound of steam at 90 lb. boiler pressure, or about 105 lb. absolute, contains 1,187.2 B.t.u. above 32 deg. F., and the conversion of 8 lb. of water from a feed-water temperature of 98 deg. F. into steam at 90 lb. boiler pressure would require

$$[1{,}187.2 - (98 - 32)] \times 8 = 8{,}969.6 \text{ B.t.u.}$$

A pound of steam at 120 lb. boiler pressure, or about 135 lb. absolute, contains 1,191.6 B.t.u. above 32 deg. F., and the conversion of 8½ lb. of water from a feed-water temperature of 180 deg. F. into steam at 90 lb. boiler pressure would require

$$[1{,}191.6 - (180 - 32)] \times 8\tfrac{1}{2} = 8{,}870.6 \text{ B.t.u.}$$

and the relative evaporating economy would be 98.8 per cent. of that obtained with an evaporation of 8 lb. of water per pound of coal under the conditions stated.

Main Bearings and Cranks Pound—We have three 1,200-kw. alternating-current generators driven by four-cylinder triple-expansion engines, 180 lb. at the throttle and 100 deg. F. superheat. When the machines are paralleled at a certain angle, they operate very smoothly; when cut in at any other angle, the engines pound. Can you suggest an explanation of this trouble? L. T. S.

This difficulty is frequently encountered when reciprocating engines are used and especially when the alternators deliver a current of comparative high frequency. The machines surge or hunt; that is, the speed may fluctuate during each revolution, thus causing large periodic cross-current to flow between the machines and seriously affecting the voltage of the system. The pounding which accompanies the surgings has been found in many cases to be due to periodic variations in the speed of the engine. The result is that, although the speed of the engine may remain practically constant so far as the number of revolutions to the minute is concerned, there will be momentary variations in speed during each revolution and these will be accompanied by surgings and poundings of the engine due to sudden variations of resistance to rotation.

Benefit of Returning Condensate—What saving is to be expected from returning the condensate of a steam-heating apparatus over discharging the returns as waste to a sewer? T. H.

The saving would depend upon the boiler pressure and the present temperature of the feed water as compared with the temperature at which the return water could be delivered to the boiler; also upon the steam used or wasted by a pump, trap or other appliance used for gathering and returning the condensate as compared with the present waste of live steam.

Assuming that the boiler pressure is 10 lb. per sq.in., each pound (weight) of steam generated would contain about 1,160 B.t.u. above 32 deg. F. With the feed water at a temperature of 55 deg. F., or 55 — 32 = 23 deg. F. above 32 deg. F., each pound of the feed water for conversion into steam would have to receive 1,160 — 23 = 1,137 B.t.u. But if the condensate were to be returned to the boiler at a temperature of 190 deg. F., each pound of steam would have to receive 1,160 — (190 — 32) = 1,002 B.t.u., and without considering the greater or less use or waste of steam, or value of the water, the saving would be (1,137 — 1,002) ÷ 1,137 = 0.118, or practically 12 per cent.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Relative Cost of Raw- and Distilled-Water Ice

Before the American Association of Refrigeration, Fred Ophuls recently presented a paper confined not so much to the actual cost of making ice as to a discussion of the factors entering into the cost figures and their variation with changes in design, operation and of the local conditions.

Records previously presented showed that the coal consumption of properly equipped simple distilled-water ice plants was 17c. per ton of ice for a plant using coal at $1.30 per ton and making 85 per cent. distilled-water and 15 per cent. raw-water ice; 36c. per ton of ice for a straight simple distilled-water ice plant using coal at $1.25 per ton and proportionately higher for plants where coal costs more. Some of the best figures for simple distilled-water plants of 200 to 500 tons capacity using bituminous coal costing at the boilers $3.50 per ton, with feed-water heaters, economizers and mechanical stokers, were from 38 to 45c. per ton of ice.

Again, taking a distilled-water plant equipped with compound condensing engines, exhaust evaporator operating on 18 in. vacuum on the high-pressure side and 26 in. vacuum on the low-pressure side, using mechanical stokers, economizers, etc., the lowest fuel cost with coal at $3.50 per ton at the boilers was 21c. per ton of ice made. Other plants had been more or less disappointing on account of the labor required to take care of this complicated machinery and the many disarrangements occurring when the water evaporated contained considerable quantities of salt in solution.

Raw-water ice plants can be operated with any available power, such as that derived from steam, electric current, oil engines, gas engines or water. Of the power sources mentioned, steam engines, electric motors and oil engines are used most frequently. Steam-driven raw-water plants equipped with the most modern steam appliances can be operated on a fuel cost as low as 13 to 15c. per ton of ice, using coal costing $3.50 per ton at the boilers.

Oil-engine-driven plants can produce ice at the rate of from 15 to 25c. per ton, depending on the design and cost of the fuel oil. The cost of power for motor-driven plants using current from central stations has been found to vary between 40 and 50c. per ton of ice, depending on the current rate and the kind of contract made with the central station.

When considering the figures here given, it may be asked, Why does not everybody install steam-driven raw-water ice plants with the most modern appliances or perhaps an oil-engine-driven plant? The proper selection necessitates a consideration of the first cost of the plant, reliability, the locality in which the plant is to be installed, labor cost, the amount and the cost of the power or fuel necessary, the suitability of the available water for making either raw- or distilled-water ice, the temperature and quantity of the cooling and condensing water and the depth of the water in the wells, if there are any, from the condenser-floor level.

FIRST COST OF DIFFERENT PLANTS

A list of the various types of raw-water and distilled-water can ice plants arranged in the order of their first cost and starting with the least expensive would be about as follows: (1) Motor-driven raw-water can ice plant; (2) simple distilled-water can ice plant; (3) steam-driven raw-water can ice plant; (4) distilled-water can ice plant with exhaust evaporator or single-effect or multiple-effect high-pressure steam evaporator; (5) gas-producer and oil-engine-driven raw-water ice plant. This list of course is subject to considerable rearrangement when plants having patent features or of special designs are under consideration.

Reliability in nine cases out of ten does not depend so much on the machinery and apparatus as such, but upon their proper proportioning for the duty required. Many failures are caused by a particular machine being too small or in some other manner not coördinating with the balance of the plant. Equipment manufactured by a reputable firm generally can be relied upon to perform the duty for which it was designed.

The location determines to some extent the type and the cost of the ice made. On account of the difficulty of obtaining competent labor at reasonable wages, labor-saving devices are installed wherever possible. Machinery driven by electric current derived from the central station does not require so much labor as steam-power plants. It is claimed, however, that more labor is necessary to take care of the freezing-tank equipment of the raw-water can plants than of the distilled-water plants. This may be true for some of the existing plants, but when the water from which the ice is made requires but one pumping out and refilling of the core, the labor item should be the same in both cases. Some of the raw-water ice plants installed are modeled too much after the design of the distilled-water plants. There are several features that can be eliminated in the former case. One is the filling of the ice cans in the tank. The time gained by filling the ice cans at the dumper end of the tank makes up for the loss of time in pumping out and refilling the cores and attending to the aërating system of the freezing tank.

In a simple distilled-water can ice-making plant the amount of fuel required depends on the steaming quality of the coal available, the efficiency of the boiler plant, the loss of exhaust steam or distilled water by leakage and the amount of distilled water required to fill the ice cans. Most of the variation in the amount of fuel used in plants of this type and of the same size is due to some difference in the design of the boiler plant. The amount of distilled water required to fill the ice cans is constant, and in plants of 50 tons or greater capacity the condensed exhaust steam available from all sources is not enough to fill the ice cans. Live steam, and in some cases raw water, is added in the steam condenser to make up the deficiency. Another loss of exhaust steam that must be guarded against is leakage and excessive condensation in the exhaust mains and oil separator. In reboiling, excessive quantities of live steam are often wasted. Excessive skimming in the reboiler or storage tank also represents a waste of fuel.

The preceding is also true of distilled-water ice plants using compound engines and evaporators, with the exception that an additional fuel saving is effected by the fact that the distilled water for the ice cans is obtained both from the condensed exhaust steam and from the vapor obtained in the evaporators.

To avoid the complications in the machinery equipment caused by the installation of evaporators and still obtain fairly low fuel costs, some plant owners have turned part of their distilled-water freezing tanks into a raw-water system, furnishing distilled water for the balance of the plant.

The problem is difficult in raw-water plants. Here the cost of fuel or power is not alone dependent on the efficiency of the boiler system or power plant, but also on the proportioning of the freezing system. A large number of ice cans, say eighteen 300-lb. cans, 300 ft. of 1¼-in. cooling coils per ton of ice, and a rapid brine circulation in the freezing tank are of great importance in making good ice and in obtaining minimum power or fuel consumption. Formerly a temperature difference of 15 deg F. between the brine and the ammonia in the freezing tank was not considered out of the way. Today more than 5 deg. F. difference for raw-water ice plants should be considered excessive and suggestive of poor design. Expending 5 hp. more in a 100-ton plant to obtain better brine agitation will save 25 hp. in the operation of the refrigerating machines.

The quality of the water used for ice making affects the fuel and labor cost of both kinds of plant. The treatment of water to make it fit for boiler feeding does not require much labor. If such treatment is used for preparing the water for making raw-water ice, two changes of the core water are often necessary, making the labor cost high. It is also true that the salts causing temporary hardness give more trouble when making raw-water ice than those causing permanent hardness of the water.

Cost figures obtained from various sources both in connection with distilled-water and raw-water ice plants can be properly analyzed only when all the items making up the cost figures, full data on the machinery and apparatus of the plant and the local conditions are known. Cost figures without the necessary accompanying data are valueless.

Program of A. S. M. E. Meeting

The thirty-seventh annual meeting of the American Society of Mechanical Engineers will be held at the society's headquarters in New York, Dec. 5 to 8. Eleven professional sessions are scheduled and an attractive social program has been arranged. The tentative program as at present arranged is as follows:

Tuesday Evening, Dec. 5, Presidential Address and Reception—The address will be on the "Relation of Education to Engineering," by Dr. D. S. Jacobus, president of the society.

Wednesday Morning, Dec. 6, Business Meeting and Reports of the Council, Standing Committees and Special Committees. Following the regular business of this session there will be memorial exercises in honor of the memory of John E. Sweet. Miscellaneous Session—"The Proportioning of Surface Condensers," George A. Orrok; "The Testing of House-Heating Boilers," L. P. Breckenbridge and D. B. Prentice; "Water for Steam Boilers—Its Significance and Treatment," Arthur C. Scott and J. R. Bailey. Industrial Safety Session—Report on safety standards for the operation of cranes.

Wednesday Afternoon, Miscellaneous Session—"The Utilization of Waste Heat for Steam Generating Purposes," Ar-

thur D. Pratt; "Graphic Methods of Analysis in the Design and Operation of Steam Power Plants," R. J. S. Pigott; "Power Plant Efficiency," Victor J. Azbe.

Wednesday Evening, Smoker—Entertainment will be provided, and a feature will be a short talk by Frank B. Gilbreth on his experiences in Europe during the war.

Thursday Morning, Dec. 7, Valuation Session—"Accurate Appraisals by Short Methods," J. G. Morse; "Productive Capacity a Measure of Value of an Industrial Property," H. L. Gantt.

Thursday Afternoon, Gas-Power Session—"A Gas Producer for Bituminous Coal," O. C. Berry; "Commercial Sampling and Gas Analysis," P. W. Swain; "An Investigation of the Internal-Combustion Engine as Applied to Traction Engines," A. A. Potter and W. A. Buck; "The Ratio of the Specific Heats and the Coefficient of Viscosity of Natural Gas from Typical Fields," Robert F. Earhart; "Illustrated Review of the Werkspoor Marine Diesel Engines," Thomas O. Lisle.

Thursday Evening—Popular lecture (speaker to be announced later). Following the lecture, the members and guests are invited to adjourn to the fifth floor of the Engineering Societies Building for the annual reunion and dance.

Friday Morning, Dec. 8, Miscellaneous Session—"The Impact Tube," Sanford A. Moss; "Heat Treatment of Wrought-Iron Chain Cable," F. G. Coburn, W. W. Webster and E. L. Patch; "The Flow of Air and Steam Through Orifices," Herbert B. Reynolds. Steam Boiler Session—"An Analysis of the Working Parts of Safety Valves Met with in Marine Practice with Suggestions for Repairs and Improvements," E. F. Maas; "The Talbot Boiler," Paul A. Talbot.

Friday Afternoon—Public hearing by the Boiler Code Committee.

Saturday Morning, Dec. 9—Public hearing by Boiler Code Committee continued.

PERSONALS

E. P. Haines is now mechanical engineer with the Curtis County Manufacturing Co., of St. Louis, Mo.

J. S. Kerins, formerly draftsman with the New York Edison Co., is now with the Dayton Power and Light Co., Dayton, Ohio.

E. W. Kerr, formerly professor of mechanical engineering at the Louisiana State University, Baton Rouge, is now with the Cuba Cane Sugar Corporation, at Havana, Cuba.

Allen V. Moyer, formerly mechanical engineer with the George T. Ladd Co., of Pittsburgh, Penn., is now chief draftsman and assistant chief engineer of Struthers-Wells Co., Warren, Penn.

H. S. Dickerson, formerly assistant professor of mechanical engineering at Purdue University, La Fayette, Ind., is now professor of mechanical engineering at the School of Mines and Metallurgy of the University of Missouri, Rolla, Mo.

Martin J. Hickey, well known among operating engineers of New York and New Jersey and who has been a member of the New Jersey Engineers' License Board since its inception, left for the South recently on account of failing health.

David Larkin has resigned his position as superintendent of the Fifth Avenue Building, New York, to become electrical engineer for the New York & Pennsylvania Pulp Co., which is to electrify under his direction the power plants of its half-dozen mills. A number of his friends gave him a farewell dinner on Saturday evening, Oct. 28, at the Masonic Club. He will be located for the present at Johnsonburg, Penn.

ENGINEERING AFFAIRS

The Marine Engineers' Beneficial Association, No. 33, will hold its annual entertainment and reception, on Wednesday evening, Dec. 6, at Lexington Opera House, 58th St., near Lexington Ave., New York.

The American Society of Safety Engineers will hold its next regular meeting in the Engineering Societies Building, New York City, on Nov. 22, at 8 p.m. The session will be devoted to the installation of officers.

The American Institute of Steam Boiler Inspectors will hold its next meeting at the Engineering Societies' Building, 29 West 39th St., New York, on Friday evening, Nov. 24. Wilbur S. Wilding, manager of the International Filter Co., will give a short talk on the treatment of water used for boiler feed and the elimination of scale by water treatment. He will bring a small testing outfit to demonstrate the simple process of approximately and quickly analyzing water.

Hoboken Association No. 5, N. A. S. E., of New Jersey, held its fifteenth annual entertainment and reception at Grand View Hall on Friday, Nov. 10. The large hall was comfortably filled. A pleasing vaudeville entertainment was followed by dancing. Frank Martin, of Jenkins Bros., was the floor manager, assisted by B. Michalski. The officers of the association are: A. Comens, president; J. J. Fagan, vice-president; A. B. Snook, recording secretary; John Platt, corresponding secretary; W. T. Johnson, financial secretary; W. H. Crary, treasurer; J. Craig, conductor; L. Bothe, doorkeeper.

Mechanical Engineers Witness Submarine Demonstration—Favored by splendid weather, the combined excursion of the New York, Boston, Providence, New Haven and Worcester sections of the American Society of Mechanical Engineers to New London on Nov. 11 proved to be one of the largest affairs of its kind ever carried out by the society. In all, about fifteen hundred participated, special trains conveying the members to New London, where dinner was served at the Mohican and the Crocker House. Later naval boats took the delegation several miles off shore, where a demonstration of submarine diving and maneuvers was given. The plant of the New London Ship and Engine Co. was later visited and a large number of Diesel engines seen on the testing floor and in the course of erection. A supper was served on the return trip of the New York special.

Subsequent to the excursion, C. H. Bedell, electrical engineer of the Electric Boat Co., gave an instructive illustrated talk on the submarine at the meeting of the New York Section on Nov. 14.

National Association of Stationary Engineers—On Monday evening, Nov. 6, National Secretary Fred Raven, of Chicago; National Trustee Henry J. Mistele, of Milwaukee; Joseph O'Connell, of Chicago, and William J. Reynolds, of Hoboken, who is Chairman of the Board of Trustees—all officers of the National Association of Stationary Engineers—presented a past president's jewel to Henry D. Cozzens, who is a member of the Newark, N. J., No. 3 Association and the founder of the National Association of Stationary Engineers. The jewel was presented to Mr. Cozzens in accordance with a resolution passed at the last national convention at Minneapolis, and the national officers named formed a delegation to confer the honors upon Mr. Cozzens. The preamble of the National Association of Stationary Engineers is the same today as when written by Mr. Cozzens 35 years ago. The Newark Association will obtain a large photograph of Mr. Cozzens and will have with it in the frame an inscription of the preamble as he wrote it. Charles H. Bromley, Associate Editor of "Power," closed the evening with an address in which he reviewed some of the recent progress in the power-plant field.

The Visiting Committee of the New Jersey State Association of the National Association of Stationary Engineers made its first visit of the season on Nov. 8 to Paterson No. 2 Association, Engineers' Hall, 74 Broadway. The members and visitors present listened to an interesting educational talk by Charles J. Mason, of the International Correspondence Schools. C. H. Bromley outlined the educational system as practiced in the Newark, N. J., Association. The visits for the season are as follows: No. 1 Association, Jersey City, 148 Newark Ave., Saturday evening, Nov. 18; No. 5, 200 Washington St., Hoboken, N. J., Wednesday, Nov. 29; No. 3, 104 Branford Place, Newark, N. J., Monday, Dec. 4; No. 14, Fred's Hall, First Ave. and Fifth St., Elizabeth, N. J., Monday, Dec. 18; No. 7, Hendrickson's Hall, 31st St. and Broadway, Bayonne, N. J., Saturday, Dec. 30; No. 13, Red Men's Hall, Perth Amboy, N. J., Friday, Jan. 5; No. 4, 219 East State St., Trenton, N. J., Friday, Jan. 12; No. 9, 714 Atlantic Ave., Atlantic City, N. J., Saturday, Jan. 27; No. 10, Red Men's Hall, Pennsylvania Railroad Station, Philipsburg, N. J., Thursday, Feb. 8; No. 12, 109 Park Ave., Plainfield, N. J., Friday, Feb. 23; No. 11, Post Office Building, Passaic, N. J., Saturday, Mar. 3; No. 8, 240 Springfield Ave., Newark, N. J., Thursday, Mar. 22. President Thomas A. Brown of the State Association has appointed the following members to the visiting committee: C. W. Oakley, Passaic; George Peterson, Bayonne, N. J.; John J. Callahan, Jersey City; E. W. Sears, Newark, N. J.; Frank R. Tuthill, Jersey City; William Wilson, Newark; George R. Starrs, Paterson; Frank Hyatt, Newark, N. J.; Chas. H. Bromley, Newark, N. J.; Frank Martin, New York City; Fred Murphy, A. B. Pinney and Jos. Greves, Jersey City.

President Brown emphasized the necessity of action to secure some needed amendments to the New Jersey Engineers' License Law. The nature of two amendments most needed is first an amendment providing some penalty for violation of the law, and second, providing for increased salaries for the members of the License Board.

MISCELLANEOUS NEWS

Rates and Charges for Electric Current—Alternating current supplied to motor-generator for operating a moving picture machine is chargeable as power. Held that the test whether current is used for power or for light is at the point of delivery and consumption, and as the point of consumption was at the motor, where the current was used for power and not for light, power rates should be charged. (Public Service Commission Decisions Vandeau Amusement Co. vs. Edison Electric Illuminating Co., Brooklyn, N. Y.)

New York Edison Rates To Be Lowered—As a result of the activities of the Mayor and Public Service Commission of New York City, the prevailing rate of 8c. per kw.-hr. (without lamp renewals) for electric current will be lowered to 7½c. on Jan. 1, 1917, and to 7c. on July 1 of the same year, providing no unforeseen adverse conditions arise, such as a further increase in the cost of coal and labor. This agreement was reached with the Edison and United companies, to apply to Manhattan and the Bronx, partly to avoid an appraisal to furnish a basis for the establishment of an equitable rate that had been ordered by the Public Service Commission and "the expenditure in time and money that would be necessary to undertake a complete inventory and appraisal of the company's property." It is understood, therefore, that no appraisal will be made and the company's offer, which means a saving of about one and three-quarters million dollars per year to consumers, will be accepted.

The Creation of a Municipal Monopoly of the light and power business and the issuance of approximately $10,000,000 of utility bonds is a proposition now before the city council of Seattle by instituting condemnation proceedings for the acquirement of the Puget Sound Traction, Light and Power Co.'s distribution system and its Snoqualmie Falls power plant, to avoid the present duplication with the city plant. The Snoqualmie plant has a capacity of approximately 19,000 kw. and represents an investment of about $2,000,000. The traction company's and the city's distribution systems within the city, including substations and equipment, are said to have about the same value, or $4,500,000 each. The city electric plant has a total of nearly 43,000 accounts, while the traction company has about 18,000 patrons. The city has made extensions regardless of returns, while the traction company counts among its subscribers the largest users of current in the city, so it is estimated that the revenue from the smaller number of subscribers served by the traction company is as much as, if not more than, that of the larger number served from the city plant. The acquiring of the private company's light and power systems, and one of its five water-power plants is but part of the general plans proposed for the extension of the city's light and power system.

BUSINESS NOTES

The Standard Gas Engine Co., of San Francisco, Calif., announces its purchase of the Corliss gas-engine plant, and will hereafter continue to build the Corliss engine.

Clarence W. Marsh has opened an office at 101 Park Ave., New York, for conducting investigations in plant design and construction for industrial, chemical and electrochemical enterprises.

The Imperial Brass Manufacturing Co. is ready to start construction of a new addition to its present plant, at corner of Harrison St. and Racine Ave., Chicago, doubling its present foundry space.

The Giles Drilling Co., Inc., of New York, announces that it has taken over the business, plant and equipment of the firm of Giles & Clarke, engineers and contractors, Mr. Edward A. Clarke having retired.

The George J. Hagan Co., Inc., of Pittsburgh, Penn., has opened an office at 406 Garfield Building, Cleveland, Ohio, where there shall be every facility for promptly filling orders for furnaces, stokers and gas producers.

Pressure Drop Due to Bends, Fittings and Valves may be taken, for bends, as equal to the same length of straight pipe; for standard radius elbows and globe valves, the length of pipe to be added is found by the formula, $cd \div \left(1 + \frac{3.6}{d}\right)$ when c = constant (for 90-deg. elbows = 520 and globe valves = 706) and d = diameter of pipe in inches. For practical purposes it is sufficiently accurate to allow for the resistance at the entrance of the pipe and for each globe valve an additional length of pipe equal to 60 times the pipe's diameter and 40 diameters for 90-deg. elbows.

Proposed Construction

Alta., Lethbridge—Citizens voted in favor of bylaw for $17,000 for additions to electric-light system.

Ariz., Duncan—J. P. Overholser and C. E. Adams plan to improve electric-light plant.

Ark., Heber Springs—Arkansas Hydro-Electric Co. plans to improve plant. G. A. Watkins, Little Rock, secretary.

Ark., England—England Public Service Co., recently incorporated with $100,000 capital stock, plans electric-light plant in England.

Ark., Gillett—Stuttgart Public Service Co., Stuttgart, plans plant at Gillett to furnish town with electric light. Company granted 50-year franchise.

Calif., Chula Vista—San Diego Electric Railway Co. plans substation.

Colo., Greede—Commodore Mining Co. plans power house.

Conn., Waterbury—A. H. Wells Co., Inc., making plans for 40x50-ft. power house. C. H. Preston, Jr., 136 Grand St., Waterbury, architect.

Ill., Fairbury—Council appointed committee to investigate feasibility of installing electric-light plant.

Ind., Edwardsport—Indiana Power and Light Co. making plans for one-story power plant.

Iowa, Buffalo—Council plans to install electric-lighting system.

Iowa, Lonerock—Lonerock Electric Light Co. plans power house.

Iowa, Sheldon—Sheldon Gas Co. making plans for plant. About $30,000. Western Gas and Construction Co., Ft. Wayne, engineer.

Kan., Hiawatha—City plans new street-lighting system.

Kan., Munden—City to vote on proposition to install electric-light plant. W. H. Stenad, city clerk.

Ky., Olive Hill—City voted $10,000 bonds for electric light.

Md., Sparrows Point—Bethlehem Steel Co. made plans for new electric generating plant and engine room.

Mass., Waltham—Board of Aldermen appointed committee to investigate lighting system with view to improving same.

Minn., Erskine—City soon to receive bids for sale of $5,000 bonds for electric-light system. O. H. Rash, clerk.

Minn., Ghent—Citizens' Light, Heat and Power Co. granted franchise for electric-light plant. C. Foulon, president.

Minn., St. Cloud—Union Power Co. plans 50-mi. transmission line. About $10,000. J. Wintermeyer, St. Cloud, chief engineer.

Minn., Waconia—Northern States Power Co. plans transmission line from Waconia to Redwood Falls.

Miss., Columbus—Council petitioned to issue $50,000 bonds for electric-light plant.

Mo., Sheridan—City plans electric-light plant.

Mo., Springfield—City election Dec. 12 on $400,000 bonds for electric-light plant. T. J. Moore, clerk.

Neb., Bertrand—City voted $11,000 bonds for electric-lighting system.

Neb., Cortland—City plans electric-light and power plant.

N. Y., New York—(Queens)—Astoria Veneer Mills and Dock Co., Ft. Blackwell St., making plans for two boiler houses. About $25,000. F. W. Korfmann, 406 Ninth Ave., New York, architect.

Nev., Gardenville—L. Ruhenstroth interested in electric-light plant in Gardenville.

Ohio, Cleveland—City voted $1,750,000 bonds for extending and improving electric-light plant. W. E. Davis, 228 City Hall, light commissioner.

Ohio, Columbus—Columbus Railway and Light Co. plans to extend transmission line to Centerburg.

Ohio, Columbus—Ohio State University making plans for power house. About $200,000.

Ohio, Hamilton—Council passed ordinance authorizing expenditure of $5,700 for improving and extending electric-light plant.

Ohio, Williamsport—Circleville Light and Power Co. granted 25-year franchise for electric-light and power system in Williamsport.

Okla., Checotah—Council plans electric-light plant.

Penn., Hazleton—L. Roessel Co. plans power house at silk plant. W. E. S. Dyer, architect.

Penn., Sunbury—Northumberland County Gas and Electric Co. plans to improve local plant.

S. D., Dell Rapids—City receiving bids Nov. 28 for sale of $8,000 bonds for electric-light plant.

Tenn., Memphis—Chickasaw Cooperage Co. will rebuild power house, recently destroyed by fire.

Tex., Hemphill—Knox Lumber Co. will build electric-light and power plant at Hemphill to furnish light and power for mills at East Mayfield.

Wash., Davenport—Washington Water Power Co., Spokane, applied to commissioners Lincoln County for 50-year franchise to build and operate transmission lines along roads of Lincoln County

Wis., Merrill—Council plans to install street-lighting system.

Wis., Sheboygan—Sheboygan Dairy Products Co. making plans for one-story power house and dairy building. Juil & Sixta, 805 North Eighth St., Sheboygan, architects.